UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE 1952 COFFEE RUST SURVEY MISSION TO EUROPE, AFRICA, ASIA AND HAWAII.

By Dr. Frederick L. Wellman

May 1974
Robert C. Moncure

INTRODUCTION

Coffee Rust Survey Mission to Europe, Africa, Asia and Hawaii
June - December, 1952 - U. S. Department of Agriculture
Office of Foreign Agricultural Relations (now FAS)

Dr. F. L. Wellman (Plant Pathologist)
Dr. William H. Cowgill (Plant Physiologist & Horticulturist)

This important scientific and historical coffee rust survey report by Dr. F.L. Wellman has never been published. The need for such a survey and the danger of introduction of this destructive disease from Africa to the Western Hemisphere had been under discussion for several years prior to the Mission's departure. These discussions by technical staff of the U.S. Department of Agriculture, working in Latin America, had been with Dr. Carlos Krug, Instituto Agronomico de Campinas, Campinas, Brazil, as well as with coffee scientists and coffee growers in El Salvador and Guatemala, and with the staff of the Inter-American Institute of Agricultural Science, Turrialba, Costa Rica. The author of this introduction vividly recalls being present in 1948 at discussions in Guatemala with Guatemalan staff, Dr. Cowgill and other USDA staff attached to the Instituto Agropecurio Nacional, at Finca Chocola, which had followed similar discussions with Salvadoran and U.S. staff in El Salvador. The author of this introduction and other U.S. Department of Agriculture staff continued correspondence and discussions over the years, including a conference I had with Dr. Krug in Rome when he was a member of the FAO staff.

Dr. Krug, in late 1970 reminded me by letter, that the Brazilian government in 1953 (after the return of the Rust Survey Mission) had granted the Instituto Agronomico de Campinas funds to begin the first rust selection and breeding program in the Western Hemisphere by Dr. A. Carvalho (now Director at Campinas). This expanding research work in Brazil at Campinas included from the beginning close cooperation and exchange of data, staff, seeds and improved coffee plants with the Centro de Investigacao das Ferrugens do Cafeiro, at Oeiras, Portugal, under its famous director, Dr. Branquinho D'Oliveira. This important research work started in Portugal in 1951, and later also included visits to Brazil by Portuguese coffee specialists from Angola. The exchange of these plants and seeds was carried out through the USDA plant quarantine and plant introduction facilities, even prior to 1955, to avoid the possibility of introduction of coffee rust to Brazil and other coffee growing countries of the Western Hemishpere. This international coffee cooperation and research set the stage for coffee rust research in the Western Hemisphere. In April 1955 the Governments of the United States and Portugal signed a formal agreement under which the United States provided funds for the expansion of this work in Portugal to increase exchange of seed and coffee plants for the Western Hemisphere through plant quarantine and plant introduction-propagation facilities of the U.S. Department of Agriculture at Glendale, Maryland and South Miami, Florida, and for eventual shipment of seeds and plants to Campinas, Brazil, the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica, etc. (The story of this international cooperative program in Portugal is found in the 1971 annual report of the Coffee Rust Research Center - Centro de Investigacoa das Ferrugems do Cafeeiro). Also this program has had the cooperation from time to time of the staff of FAO - United Nations. The author of this introduction has visited and conferred with Dr. Branquinho D'Oliveira and staff in Portugal a number of times, the last time in 1971.

As indicated in the press release of the Office of Foreign Agricultural Relations, U.S. Department of Agriculture, dated December 5, 1952, the Coffee Rust Mission was sponsored by the United States Point 4 program and financed by the Institute of Inter-American Affairs. It had also the whole hearted endorsement of the United States coffee processing and buying industry, which sent a special industry committee to

Washington in early 1952 urging that the mission be promptly despatched on its survey trip.

When the coffee rust was first officially discovered in Brazil by Brazilian scientists, the Brazilian government invited Dr. F.L. Wellman (now at North Carolina State University), Dr. Eugene Schieber of Guatemala, Dr. Branquinho D'Oliveira of Portugal, and others to survey the coffee areas and the potential damage, and to make recommendations for control, including discussions with the staff at Campinas. Later the International Coffee Organization in London sent Dr. J.A.N. Wallis to appraise the situation, because of his long experience with coffee rust in Kenya. As a result of the long development and research program on coffee rust and breeding for rust resistance at Campinas, coupled with more recent biological and spray methodology work of the Instituto Biologico de Sao Paulo, Brazil was more ready with expanded programs for control of coffee rust than any other country in the Western Hemisphere. Almost immediately the National Academy of Sciences of Brazil organized a coffee rust study commission under the direct coordination and leadership of their eminent coffee specialist, Dr. Carlos Krug, and a large body of survey men were given training in searching for and identifying the rust infections on coffee.

In late 1970 a Round Table Conference on coffee rust was held in Bogota, Colombia at the Latin American Reunion of Phytopathology, at which Brazil was represented by Dr. Carlos Krug, Dr. A. Victoria Rosetti (Instituto Biologico de Sao Paulo) and others. In August 1972 a further panel of papers and discussions was held in Mexico City at the annual meeting of the American Phytopathology Society, with scientists from many countries in Latin America and the United States. (Publication of these proceedings is still in press) Brazil has initiated a vast program for spray control in the various coffee areas, including demonstration plots and extension programs. Coupled with this work is an expanding nursery propagation and distribution program for various proven resistant new coffee varieties. At the same time the staff at Campinas is also continuing with its long term as well as immediate research programs. In August 1973 I had the opportunity to visit Campinas and confer with Dr. Carvalho and Dr. Ortoland and staff and to judge the wide scope and soundness of the coffee rust work, including use of computers, and also to confer with Dr. Rosetti and staff at the Instituto Biologico. Dr. Carvalho showed me third generation field coffee plantings from seed sent him in 1953 through USDA by Dr. Wellman. These he termed Dr. Wellman's "coffee grandchildren". Details and results of much of this current work will be found in the August 1973 publication: "Instrucoes para o controle da ferrugem do Cafeeiro no Estado de Sao Paulo."

Appended also is a brief current bibliography on coffee rust, which is not intended to be comprehensive, and does not include the discussions at the 1970 Round Table conference on coffee rust at Bogota, Colombia, or the discussions in August 1972 of the American Phytopathology Society. A map showing the coffee diseased and non-diseased areas of the world, as published in "Foreign Agriculture" (USDA), September 1952 is made a part of this document.

Because of the scientific, historical and practical value of this 1952 world coffee rust survey mission, The United States Department of Agriculture believes that a very limited number of photocopies of this report should be made available to a few basic libraries and research institutions in the United States, Latin America, United Kingdom and Portugal, from whence microfilm or other copies can be made available to research workers and students around the world.

The survey report is also valuable for the names of institutions and individuals who were working on coffee and related matters in Europe, Africa, and Asia in 1952, many of whom, to my personal knowledge, are still actively involved, although not always at the same location.

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May 1974.

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May 1974.

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UNITED STATES DEPARTMENT OF AGGRICULTURE
Office of Foreign Agricultural Relations

(For P.M. Release December 8) Washington, December 5, 1952.

Point 4 Locates Rust-Resistant Coffees to Safeguard Latin American Production:

Coffee hybrids resistant to a rust disease that is a serious threat to the coffee industry of the Western Hemisphere have been found in South India by two plant scientists of the U. S. Department of Agriculture who have just returned from a 36,000 round-the-world-search for coffee plants with such resistance.

The two men are Dr. Frederick L. Wellman and Dr. William H. Cowgill of the Office of Foreign Agricultural Relations. Both are well known for their work in helping Latin America improve its coffee production. The mission was sponsored by the United States Point 4 program and financed by the Institute of Inter-American Affairs. All important coffee-producing areas of the Eastern Hemisphere were visited on the 5-month trip, including Africa, South and Southeast Asia, and Pacific islands.

The purpose of the exploration, which covered 20 countries, was to find ways and means of combatting a rust called Hemileia, which, although not present in the Western Hemisphere, is a constant threat to Latin America's billion-dollar coffee industry and could spread rapidly should it find its way into this Hemisphere. This rust, which kills coffee trees rapidly and is easily transmitted, virtually wiped out the Eastern Hemisphere's coffee industry in the late 19th and early 20th centuries. The coffee species Arabica, whose berries are preferred in the United States for their quality and flavor, and which has been planted almost exclusively in this Hemisphere, is particularly susceptible to the disease. Arabica was grown almost exclusively in the Eastern Hemisphere also, until Hemileia rust wiped out the plantings. Canephora (Robusta), a sturdier but less flavorsome species, now has largely replaced Arabica in that area.

For the present, an answer to the threat of Hemileia apparently has been found in the Arabica hybrids growing in South India. The plants are the result of nearly 30 years of breeding work at India's Coffee Research Station at Balehonnur, Mysore State. Early in the India coffee development program, crosses were made between Arabica and Canephora (Robusta) plants. Strains of Canephora were used because of the resistance of that species to Hemileia rust and Arabica was used because of its quality and flavor. After Hemileia resistance had been transferred, later plant strains were developed through cross breeding of Arabica only. Resulant hybrids were recently released to several growers in India for increase, and a small start has been there in commercial production. Indian Government officials, including those at the Coffee Research Station, indicated that they would cooperate wholeheartedly in introducing these Hemileia-resistant coffee trees into the Western Hemisphere.

Seeds of the Arabica hybrids are being shipped from India and are expected in Washington, D. C. this month. The seeds will be prepagated in quarantine in the USDA Plant Introduction Garden at Glenn Dale, Md. Upon release, most of the seedlings will be sent to cooperating agricultural experiment stations in Brazil, Colombia, Costa Rica, and Puerto Rico for planting in test plots

(more)

If offspring of the plants developed in India prove successful in this Hemisphere, Dr. Wellman and Dr. Cowgill estimate that it will be possible to have them in fairly large commercial production in about 5 years. The scientists emphasize that a successful introduction of rust-resistant trees will not be the total answer to the Hemileia menace, but will at least put the coffee industry of this Hemisphere ahead in the unending race against plant disease.

Drs. Wellman and Cowgill collected approximately 100 different coffees that are not grown in the Western Hemisphere. Some of the collection is in the form of seeds and some in the form of living plants. As in the case of the hybrid material from India, the new coffees will be grown at Glenn Dale under quarantine and distribution will be made eventually to cooperating experiment stations in Latin America. In exchange, improved coffee varieties from Latin America will be sent to the Eastern Hemisphere cooperators.

The two scientists pointed out that the introductions will make possible a highly desirable broadening of the genetic background of coffees grown in Latin America. At present, this background is extremely narrow. As far as can be determined, virtually all coffee trees grown in the Western Hemisphere spring from one plant, or certainly no more than several Arabica plants, grown under greenhouse conditions in France early last century following introduction from Africa. Offsping from the French introduction s were transplanted into the Americas and the eventual multiplication now accounts for an estimated 5 billion Arabica coffee trees in Central and South America and the Caribbean area. The introductions should materially aid Western Hemisphere scientists in their efforts to breed resistance to disease, resistance to drought, and higher yields.

Besides locating new coffee planting materials, the two scientists also established valuable contacts with scientists of other countries concerned with coffee production problems and obtained valuable data resulting from the years of research performed on the common problems in those countries. The two scientists are hopeful of setting up a continuing exchanbe of technical information, as well as breeding program cooperation, between principal coffee experimenters of the world. The two men reported a high degree of cooperation from officials and technicians in every country visited.

Dr. Wellman and Dr. Cowgill observed that coffee prices, based on quality, are lower in the United States than those encountered anywhere on their trip. Americans drink nearly 115 billion cups of coffee a year. In terms of dollars, green (unroasted) coffee is the leading import into the United States. Eighty-five percent of the world supply is grown in Latin America. Coffee exports bring about $1-1/3 billion annually to the 16 Latin American countries that lead in production and this income is vital to the economic stability of these nations. Current world demand for coffee exceeds production.

In their coffee research work in Latin America, Dr. Wellman, a plant pathologits, is stationed at the Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica; and Dr. Cowgill, a horticulturist, is stationed at the Instituto Agropecuario Nacional, Guatemala City, Guatemala. Both stations are cooperators in the United States Point 4 program.

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USDA 2628-52.

Frederick Hulbert

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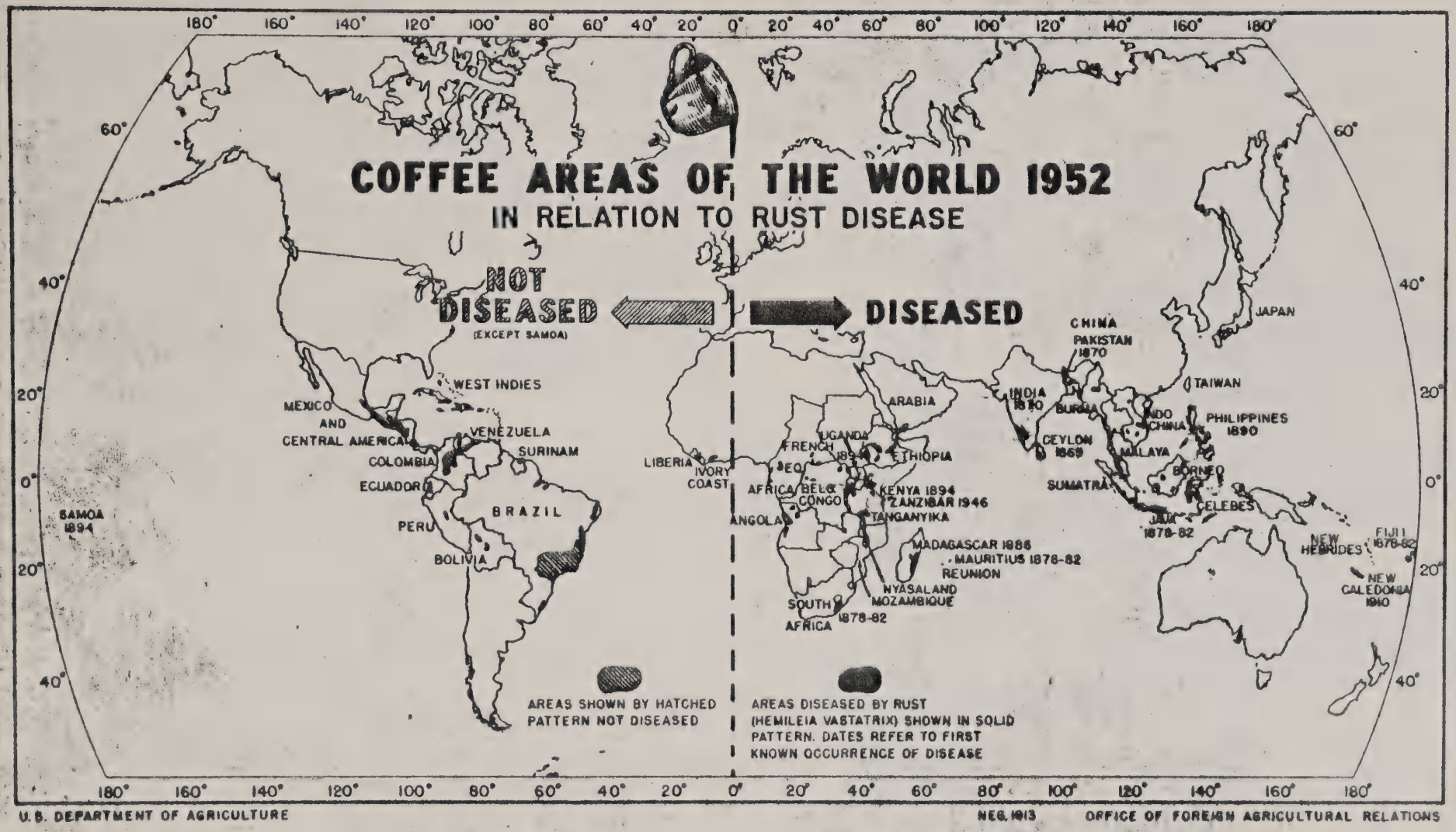

From Foreign Agriculture, September 1952, Vol. XVI, No. 9.

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

[redacted]

August 2, 1952

To: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Department of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

Subject: The European stops made by Wellman and Cowgill on this World Coffee Trip

Preparations for a trip are not always lightly made. [redacted] trip around the world it requires much consideration. [redacted] so when the trip envisions two technicians of a government, [redacted] common for two plant specialists to be so fortunate as to be thus involved. It is nearly ten years since the first thinking and planning began for this travel.

The background and purpose is briefly as follows. We have a large coffee industry in the Western Hemisphere, that makes over a billion and a third dollars in exports for some 16 countries in Latin America. No one has estimated what it means inside those lands in livlihoods and developments, but it is probably greater again than export figures indicate. The lifeblood of exchange in Latin America is very closely attached to coffee, and 6 countries are very largely dependent upon it. These countries are all using one species of coffee that came originally from a handful of seeds. This is the more amazing when it is realized that all these coffee trees are extremely susceptible to the rust disease (Hemileia vastatrix), which through sheer luck has never become established in the Americas but is the most serious and severe disease of coffee in the world. It originated in Africa and has spread all over the Orient and most of Africa destroying, like a fire, the coffee industries of country after country. The purpose of this trip is to see this disease in as many countries as possible, to study it, to become personally acquainted with those scientists working on it in the Eastern Hemisphere, and to bring back to the Americas knowledge and plant materials that will allow coffee farmers to be confident that if the dread scourge comes it can be successfully fought.

We began our trip from Washington on June 30, 1952, with our first stop in New York City where final purchases and completed arrangements were made with air line companies. This trip is to be almost entirely by air, and around the largest circumference of the globe through its greenest parts of the Tropics. We will go back and forth over the equator several times. Going eastward it seems that we will lose a full days time from the calendar somewhere. One wonders what happens to it? Will we have to turn around and go in the other direction to get those 24 hours back? If not, do we die someday having frittered away a whole day without living it?

London, England: July 3 to July 10, 1952

On arrival in London we were met by a U. S. Embassy car and taken to a hotel where reservations had been made for us by Dr. Eric Englund, old OFAR man and Agricultural Attache for England. We arrived late in the day so could do nothing, but the next days were indeed full. Visits were made to the Kew Gardens, where we worked with the Mycologists, Horticulturists, and Librarians of the Commonwealth Institute and of the Kew Gardens itself. Some special work was being done in plant propagation that Cowgill was taken to see, while I went through the two libraries searching for literature for which we had citations in Washington but which were not available for reading. (This was a special request of Dr. John A. Stevenson, Head Mycologist in Beltsville, who has gathered some 900 or more citations on the coffee rust disease. A total of 46 of these he had seen only as citations. Of these I found only 17 in Kew, which I felt spoke wonderfully well for our literature coverage in the United States.)

While in Kew, both at the Commonwealth Mycological Institute and at the Gardens library I discussed the problems of coffee Hemileia with Dr. Wiltshire, with Dr. Bisby, and with Dr. Dennis. I was specially interested in the possibility of there being two well recognized species of this rust organism, because at one time I had come to the conclusion that H. vastatrix and H. coffeicola were synonyms. The first was originally described in 1869 and the latter in 1934. Stevenson after consultations had concluded that they were separate species. In England, I found two schools, one believing in separate species and one that believed that at most H. coffeicola was a race or strain of the original H. vastatrix. Both Dr. Wiltshire and Dr. Dennis showed me herbarium specimens of the two so-called species, we consulted literature, and it seemed difficult at that time for me to conclude just what I thought, without more study. Anyway, the French were the discoverers of H. coffeicola and I hoped to discuss this further when I saw workers in France. It is an important question of fundamental concern for us. If there are two species the effects of one may be very different from the other. They may require quite widely separate types of resistance for control, and their environmental relations may be quite dissimilar. Thus far the coffee growers in English colonies and protectorates have not had to be concerned about more than the old, well-known H. vastatrix.

Our morning spent with Dr. Herklots, Director of British colonial research was most helpful and interesting. He gave us some very clear impressions of what we were likely to find, and the names of many we needed to know. One of the most helpful features of the visit was the information he could give us about centers of coffee culture and the progress of scientific work in research in these centers. Dr. Herklots had already sent word ahead to workers in the colonies we expect to visit, introducing us and the type of work we hope to accomplish. He sent supplementary notices after we left his office.

Considering that we were in London over the 4th of July and a weekend we got much done. The touch we got with regard to research of other nations colonial research was additionally very worth while. We were given names that helped us in many instances as we were to work on through Europe. Altogether my impression was that England and its efforts in our regard is sincere in its friendly words. There is no question about that. It is willing and anxious

to help where it can and to work out cooperative relations and as well to trade information and materials. There is no sense of frustration in the country, no hesitation in carrying forward towards the stand it has long taken of leadership in Tropical world science, in spite of losses in colonial possessions.

Amsterdam, Holland: July 10 to 14

Our next stop was in Amsterdam. Holland is another country that has lost heavily in Colonial possessions in accordance with the change in the temper of the times, but Amsterdam is colored on all sides by influences of the Oriental empire of the queens of the Netherlands. The city is the first city in Holland, and while The Hague is the seat of government we found so much in Amsterdam that the time was too limited to take the rail journey for the sake of the visit to The Hague. Our U. S. Consul General, Mr. Frederick Von Anderen, gave us much help from the very first. He assisted us in orientation as to who we were to see, and made contacts with Mr. Dirk Tollenaar, a long time Dutch Government hand in Indonesia, now in the old firm of H. C. Th. Crone one of the great coffee and cacao firms of Europe. We talked with Tollenaar largely about whom to see in Indonesia, changes in research programs, areas we should visit, the locations where Japanese occupation forces had eliminated coffee work and other research activities, and about where Tollenaar himself worked and about our own work in Latin America. He is sending letters to old friends, who he never expects to visit again because of the danger to Dutchmen there, but who he says will be very helpful to us.

One day was spent in the Institute of Tropical Agriculture with Dr. Luytjes Director and who had worked 30 years in Indonesia. We met and talked with others, notably Mr. Grader, and Dr. Utermark. Throughout it was that satisfying concord of scientist to scientist. They are anxious to work into a sort of Point IV program of their own, with cooperative programs and the use of services of their considerable force of well trained specialists in tropical agricultural research. Mr. Grader has made overtures to the Institute in Turrialba for cooperative publication of abstracts from work in the Oriental Tropics, to be put into English. The Dutch have made a profession of abstracting, and they wish to spread their efforts.

Meanwhile, as we went from place to place in Amsterdam, we could not help but feel the cordiality of the people. The scientists are rightly proud of their work and also concerned that the rest of the Tropical World knows so little of it. One man said, "We speak of the Holland tongue as our own secret language. Now we want to get our results out to the world in English, so it can be used."

It was of interest to learn that in Holland, as well as England, the modest work of the United States Office of Foreign Agricultural Relations was well known and respected. In both countries the specialists spoke highly of the technical work that has come out of the short period it has been in operation. They have appreciated the idealism and at the same time the practical sense that has gone into establishing agricultural research among Latin Americans. Their feeling is that we are just on the threshold of the time when research can lead where production needs to turn. From bitter experience they acknowledge that establishing research should precede education and extension, that it acts as the groundwork upon which the latter efforts must be based. These

are their thoughts, and based on generations of work. From such logical procedure, they have found, comes the mutual understanding and trade. Their failures they admit always are attributable to too rapid movement and impatience with the slower walk of thoughtful development for mutual good. One man said, "World relationships depend on research in every form. It is now the very heart and soul of advancement, and we have learned that almost too late."

Before leaving Amsterdam we visited the Botanical Gardens and saw there a few struggling coffee trees of arabica, congensis, and liberiaa species. There is a story, you know, that all Latin American arabica coffee came from just such a few trees in Government glasshouses of Europe. As Cowgill pointed out you could see just how that would come about from what we saw there. He could get no confirmation of such a report in the short time he had to investigate. It would be interesting if proof could be documented to prove that story.

We left Holland with a good feeling. We know that we shall be able to do much more in Indonesia because we stopped in Holland. We can appreciate the mountain of research the Hollanders left behind when Indonesia became an independent state. We believe we will be helped to get what we wish in Java and Malaya through our contacts with the Dutch scientists, who, although gone, exert the scientist's unselfish influence in those lands.

Brussels, Belgium: July 14 to 17

Our special reason for stopping in Belgium was that we planned to do some work in the Belgian Congo, and hoped to meet members of the Institut National pour l'Etude de l'Agriculture du Congo Belge, more commonly known as "INEAC". It is the research institution of the Belgians in Africa and has a wide reputation in Tropical science. The help of the U. S. Agricultural Attache, Mr. Anderson, (friend of our Dr. Glen Taggart and associate of Glen's brother Spencer while in Checkoslovakia), was extremely valuable. He took us to all of our appointments, and he likewise made those very appointments. The use of Embassy cars and facilities added greatly to the economy of our time, which was much appreciated.

A very important visit was with Dr. Jurion, who is a long time fan of the works of our Dr. Pendleton, and who knows Dr. Kellogg and worked with him and Pendleton on a soils study in the Congo. As Director of INEAC he had served long in the Congo, and was able to give us much first hand information about transportation, where we would find the things we were interested in seeing, and offered every facility. Furthermore he has written the scientists there by how, telling when to expect us, and telling where we want to go and what we are doing. This will be a great help. We also talked with others, but mostly Dr. Jurion. Dr. Cowgill had a long visit with Dr. Stoffels of INEAC who spent many years in Java and the Belgian Congo. Stoffels had isolated coffee strains resistant to Colletotrichum. He had worked on many problems Cowgill is interested in, one of them was primary control of dieback.

We likewise visited Dr. van der Obeele, Administrator General of the Colonies. Before we went to see the Administrator we were uncertain as to what the official government attitude might be towards such a visit as we had proposed in the Congo. Our reception was, however, most gracious and cordial. They want

contacts between scientists, and we were assured that everything would be done to make our trip successful in the Congo. The Administrator promised to send letters to that effect.

We also visited the Royal Botanical Gardens in Brussels. They are beautiful, not large, but well kept and crowded full of carefully labelled plantings. We found no coffee in their tropical greenhouses. Brussels is a fine old city dating from the Middle Ages, but there is no sense of decay about it. The people are hard workers, and indeed it is well that they are since wars have a habit of making their country a battleground. It was evident that they need produce from the Tropics, and that they were both intelligent and proud of what they were accomplishing in the Congo. As in England and Holland, the relation of one scientist to another was an opening beyond compare. We wondered what we would find in Paris.

Paris, France: July 17 to 23

When one arrives in Paris he must inevitably feel its centuries old conservatism, and at the same time its vigorous sensitivity toward the future and the peoples eternal sensibilities towards the new ideas and the things as yet untried. It was marvelous to go through this grand old city. However, beautiful as it is we felt that our own Washington was still more handsome. Be that as it may, Paris is great and lovable, and its scientists reckon back their mental and regional lineages to Medieval and Roman times. We were anxious to see what we would find.

On discussing our problems in the office of the Agricultural Attache, we found Dr. Herrmann gone, and were told many people would be out of the city. This was the vacation period for Paris. We saw Dr. Bates, and contacts were made with Colonial offices. We were taken under the wing of M. Boussingault, who is attached to the Agricultural Attache's office. His great grandfather was the old horticulturist and traveler of the same name, who traveled with Humboldt. A genus of plants was named for him. He was an confirmed idealist, who admired, helped and advised with the great American liberal internationalist Simon Bolivar. It was good to have a relative of Boussingault to assist us. He was, as you could expect, highly helpful in his bilingual handling of our problems when we failed to grasp all that was said to us in French.

A most satisfactory visit was to the offices in Nogent-sur-Marne, near Paris, at the national agricultural department's section of application of techniques in tropical agriculture. There we met and conferred with Dr. Maistre, Director and an agronomist, and Dr. Bouriquet, plant pathologist. There was much for Cowgill and Maistre to discuss. They exchanged experiences on coffee growing problems, and talked about the work and the workers in the French Camerouns and in Madagascar. They also went over the best locations for visits and talked about securing materials from each other, and went into transportation problems.

While they were doing this Dr. Bouriquet and I withdrew to one side and talked. We talked about Hemileia coffeicola that had been described from French Africa in 1934, and the differences between it and H. vastatrix. We looked at comparative herbarium materials, and the characteristics seemed to vary sufficiently that there was a good basis for making them two species. I understood from

Bouriquet that it was confined to the Congo region only on coffee arabica and in an area surrounded by isolating geographical features of various sorts, and was not complicated by the presence of vastatrix. We also talked about mutual problems on the serious Fusarium effects on coffee. It was fascinating to learn more of the 25 years of African work on this dread disease that is causing so much damage there and is becoming more and more recognized as serious in Latin America.

Attempts were made to see several other people with varying degrees of success. While I gave some attention to visas and transportation, Cowgill visited the Botanical Gardens and saw one struggling coffee tree in it, but through no fault of his, was not able to make connections with Dr. Chevalier the most renowned coffee taxonomist now living. The old worker has recently retired. However, contacts were made with M. Lagarde who told Cowgill that he was quite skeptical of the propriety of considering Hemileia coffeicola as a separate species from vastatrix. His work has been in Dschang, from which he had recently come for furlough and vacation. Cowgill was also told that strains of coffee have been isolated that are resistant to Colletotrichum, especially the fruit drop caused by this organism. Such bits of information as these which I had not known indicate how much we need closer contacts between Western and Eastern workers on these problems.

We left Paris feeling good about our stop there. We had been slightly frustrated because some people were gone on vacation, but we had been promised that letters were being sent to French workers in their protectorates both by the scientists we saw, and by Dr. Sagot, Inspector General of the "Ministere de la France d' Outre-Mer". Our stock-in-trade was the very evident fact that we were two scientists wanting to know other scientists, and that was all. It was simple as living, and in some cases most exciting. Scientific knowledge in the process of exchange is of the stuff from which understanding and friendship is made.

Lisbon, Portugal: July 23 to 28

A little of what we would find in Lisbon was heralded to us in a letter from the U. S. Agricultural Attache, Mr. Howard, who is well known in USDA and OFAR circles. It was good to be met at the airport by him and his wife, cleared rapidly through customs, signed in at the hotel, and then taken out to his home where we were given of the hospitality and friendliness of a fellow worker. But before we had left the airport, one of Portugal's (and Europe's) distinguished pathologists, Dr. Branquinho d'Oliveira, came to welcome us. He was the key, so Mr. Howard told us, and we obtained much help from him.

In the time we were in Portugal we had every working hour filled, and then some. The insight and the genuine enthusiasm of Dr. d'Oliveira was wonderful to see. He knew the important people in our case, and took us around with Mr. Howard to see them. An old student of his Eng. Agron. Medina had just gotten in from Angola, and he told us of the work in that overseas possession. He is the important man in the coffee there and here again he and Cowgill exchanged experiences in their coffee work, becoming better and better acquainted as the

conversations legthened and ramified into different phases. Medina is an active and an intense person who likes his work, and likes the Tropics. He will, unfortunately, not be in Angola when we get there, but he is sending word to his colleagues there, and to those under him, which will give Cowgill and me a big head start when we arrive. They do not claim great strides in research in Angola, but they feel that they are on the way, and some of their problems sound as if there might yield to studies similar to those Cowgill has carried out or advised upon in Latin America.

We met, at separate times, with Senhor Pereira Coutinho, President of the coffee export board and also with Senhor Francisco Monteiro Grilo, agricultural minister of overseas possessions. Each were interested in our project. At one time there seemed to be some question as to what we were after. Even the slightest hesitancy immediately disappeared when it was known that we were two plant scientists, wanting to know their scientists and see their work, and that we were anxious to bring to them whatever our facilities had to offer, and hoped to obtain from them help on our own problems. They both promised to send letters to their officials announcing who we were and our arrival, and giving official acknowledgment for our assistance.

A visit was made to the colonial botanical garden and museum, where colonial staffs are trained and come for advanced study on problems in their far flung possessions. (A point of interest is that they do not speak of "colonies", but of "overseas possessions". Ethnological and sociological studies are going on in these possessions for the advancement of the people there, and much effort is being given to make the possessions attractive places for immigrants from the homeland.) In the herbarium of the colonial museum and in a second herbarium at the Botanical Gardens, were seen some fair-sized stacks of dried coffee plant specimens from some of the heart of the place where the genus Coffea arose. In the short time at hand it was of course impossible to make critical observations. However, Cowgill was of the opinion that there was material there that had never been described, and much had not been labeled. The most serious student of these things died some years ago and no one has arisen to take his place. They need and deserve intensive attention from a first rate botanist, who is a special student of Coffea. The important thing that appears is that there are undoubtedly new things that have never been put under experimental or any other cultivation. Some are apparently unique types, for example with very small almost scale-like leaves. Some are adapted to sand dunes, some are distinctly deciduous and some are low-growing with a wide-spreading habit. How near these are to Arabica types is not known, but the natives are fond of some of them preferring them to the commercially grown coffees for their own consumption. Cowgill is already laying groundwork that will allow him to secure some of these types.

At the moment, given time, backing from coffee interests, work, and a little luck, the possibilities of growing coffee of wide horticultural adaptability seem almost unlimited. It seems safe also to predict that with such variation in genetic constitution as appears to occur, the probabilities are very hopeful of eventually securing disease resistance to Hemileia, of whatever species, and any other diseases.

Undoubtedly the most exciting thing that I, as a pathologist on this special project, saw in Europe was in a greenhouse in Portugal, living coffee plants that had been inoculated and were diseased with Hemileia vastatrix! This was

the work of Dr. d'Oliveira. He visited the Island of Sao Tome, off the coast of Angola in the summer of 1951. Not only did he find H. vastatrix there on coffee, but he found H. coffeicola as well. He collected herbarium material of both rusts, and in addition took back to Portugal with him living plants with both species of rusts. These of course were handled in most cautious fashion and on landing upon home soil he quickly transferred rust spores to coffee plants he had growing in his greenhouses. Both rusts gave further infections following upon artificial inoculation, and he soon had material with which to work. He kept the rusts in separate houses, but considered that in appearance and from preliminary action that they were quite different in those autumn months, and he felt that they were at least two strains if not two species.

The winter came and with an unusually cold spell that destroyed, in the greenhouse, his coffee seedlings that were diseased with H. coffeicola. But in the second greenhouse his other plants diseased with H. vastatrix survived. He showed me all of his techniques and he told me all that he had learned. It takes 18 to 20 hours to infect plants under his conditions. It also requires about 20 days before the first symptoms of the disease occur. He was gradually repeating all of the studies made in the 1880's by the great mycologist H. Marshall Ward on his first step towards eminence. Said Dr. d'Oliveira, "This will be for me in memory of that Great Man."

He had 25 or 30 arabica and liberica coffee seedlings all diseased with the Hemileia vastatrix. He had not been able to infect liberica coffee with H. coffeicola, although it was virulent on arabica coffee. This corroborated his field observations in Sao Tome. He was still slightly uncertain about whether we should accept specific or strain difference in the two rusts. He felt it never could be settled until it was made the subject of adequate research under cultured conditions, standard for rusts.

Before leaving Portugal, I should report that I gave a talk before the Seminar Group of the National Agronomic Station. The subject, by special request, was "Work in the Turrialba Institute". This I discussed at some length, weaving into it the history of the institute and as well the place both unilateral and multilateral cooperative work have in the Western Hemisphere in connection with the technical assistance (Point IV) work in Latin America. I, of course, covered the coffee work at the Institute, with special stress on my own disease studies. The question period was a long one, and much was discussed, from the luminescence of fungi to the use of the project outline in a research program.

Again and again, I ran into a great interest in international science in Portugal. It gave me a slight foretaste, I believed, of the things I might see in Rome under the United Nation's Food and Agriculture Organization (FAO) which was our next objective.

Rome, Italy: July 28 to August 2

There were some important reasons for stopping in Rome. For one thing we had been asked by FAO to confer with them a few days about their coffee project now starting in Ethiopia. They wished to know more about our purposes on this trip around the world, and were anxious that Dr. Sylvain, their coffee expert,

be with us for a while as we got around to the part of the world where he is stationed. It will be recalled that Dr. Sylvain is on leave from the Institute in Turrialba, where he holds the position of (coffee) Plant Physiologist. He is well known to both of us, he will be of help to us, and we will welcome seeing him and having him with us. This will assist not only FAO but also the Turrialba Institute. Anything we can do in "Point IV" or OFAR to be of service to Turrialba or FAO we are anxious to accomplish.

After all FAO and Turrialba are arms of the United Nations effort, which reaches, in a manner, ahead of even Point IV technical assistance. My belief has always been that it is a part of our duty in Point IV to do anything we can to enhance the value of the work of the United Nations. I am sure that it was with a sense of the highly valued subservience to the world cause in Agricultural production that OFAR and Point IV (TCA) administrators agreed to our visit to FAO in Rome.

All of our connections with FAO in Rome, and all of our visits there, were made with Mr. Windell Hayes, Agricultural Attache liaison officer to FAO, in our Rome American Embassy. He was extremely helpful, as he knew all the men we were interested in seeing. We met briefly Director General Dodd, and Sir Herbert Broadley, Chief of the Expanded Technical Assistance Program. More extended discussions were held with Dr. R. Innis concerning their proposal that Dr. Sylvain join us somewhere in Africa. It is hoped that we can go over some of the world coffee problems together with certain of the British specialists we will meet in East African Protectorates. We were given some idea of what Dr. Sylvain had done, and we talked as well about the future plans of the coffee work in Ethiopia, with its relations to Brazil, the Turrialba Institute, and the Organization of American States.

Later a meeting was held with Dr. Phillips, Dr. Kirk, and Dr. Ritchey again to discuss our coffee trip, the part FAO's mission in Ethiopia can plan in it and how we may be able to help Sylvain there. In addition Dr. Phillips informed us that FAO had made a proposition to Dr. Allee that a meeting of coffee specialists be called in Turrialba after Cowgill and I return from this world trip. The meeting would be of a select group to discuss technical problems in coffee research. It would include reports of the trip Cowgill and I are making and the place some of our findings would have in future research. I subsequently wrote to Dr. Allee suggesting March 1953 as a good time for the meeting so far as Cowgill and I were concerned.

I also talked with Dr. Kirk and Dr. Linn about the highly important effort sponsored by FAO, in developing a world-wide plant quarantine convention. This had crystallised into the FAO International Plant Protection Convention, recently published, and signed by 37 countries of the world. Of these 11 belong to the Organization of American States. I have been most especially concerned with the progress in this matter because of the help it will give against entrance of Hemileia rust into the American Tropics through pure negligence or criminal oversight. I feel at this time that problems of protection and quarantine against Hemileia of coffee should be one of the important subjects of the FAO meeting of coffee specialists to be held in Turrialba.

It was a sobering and gratifying experience to be taken to see the committee rooms and the great meeting hall of FAO with its well worked out system to

eliminate language difficulties. In spite of what the newspapers print at times one can see here proof that the world is interested in Internationalism. Rome is rightly called "The Eternal City", and rightly poets, historians, and great thinkers have admired and loved its ruins and its existence. It has lasted for several millenia. I think it is probably eternal because there have lived in it various peoples with genius for attracting just such high minded things as this world business of FAO. When I recall, back in history, what Rome stood for before the Christian Era, and before that, the humans and thoughtful teachings of those great masters of the dim times, it gives me pause. It is not surprising that there should be built in Rome, of all cities, the great and attractive international agricultural building where FAO is housed.

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There are a few features of our European experiences that deserve some special comments. We found, for example, that as we arrived in all countries we had some slight reservations as to how we might be received. In no case has it been anything but gracious and sincerely helpful. I believe this was because we were scientists talking with scientists or administrators who had had a scientific training. In all cases excellent maps were brought for us to work with, and Cowgill made the most of each opportunity in tracing our travel plans. It should be mentioned here that the Horticulturist's problem takes in perhaps a somewhat wider scope than that of the Pathologist. What I shall need to observe and study is well within the limits of the points of travel where Cowgill will need to go for his observations and work.

We tried to make it clear in all our discussions that we meant this trip to be if possible, of value in both directions. While we will be given free permissions to take seeds and other coffee plant materials from countries we visit, we repeatedly stated that we were anxious to be of service in connection with sending to them, in whatever country, materials we have now, or in the future. One of our most often repeated purposes in this trip has been to get acquainted with brother scientists, the workers themselves. This has invariably been received with warmth, with a statement of full understanding, and with much wished for cooperation and exchange of publications and information.

List of Key Men Conferred with at Some Length in Europe

(Does not include U. S. Embassy Officials)

1. Dr. S. P. Wiltshire, Director
Commonwealth Mycological Institute,
Ferry Lane, Kew, Surrey, England

2. Dr. G. R. Bisby, Mycologist
(address above)

3. Dr. N. L. Bor, Ass't. Director,
Kew Gardens, Surrey, England

4. Dr. R. W. G. Dennis, Mycologist
Kew Gardens.

5. Mr. Marshall, Librarian
Kew Gardens.

6. Dr. G. A. C. Herklots, Director
of Colonial Research
Colonial Office
Sanctuary Building, Great Smith St.,
London S. W. 1, England

7. Mr. Dirk Tollenaar
c/o Firma H. G. Th. Crone,
N. 2. Voorburgwal 104/108
Amsterdam, Holland

8. Mr. A. Luytjes, Director,
Division of Tropical Products
Royal Tropical Institute
Amsterdam, Holland

9. Dr. W. L. Utermark, Curator of
the Museum
Royal Tropical Institute
Amsterdam, Holland

10. Mr. Ch. J. Grader, Head of
Documentation
Royal Tropical Institute
Mauritskade 64
Amsterdam, Holland

11. M. F. Jurion, Directeur Général
Institute National pour l'Etude de
l'Agriculture du Congo Belge (INEAC)
Brussels, Belgium

12. Dr. E. H. J. Stoffels
Formerly INEAC, now Professor in
University of Brussels

13. M. Marcel van den Obeele, Administrator
General of the Colonies
25 Avenue de Forstraets,
Brussels, Belgium

14. Dr. M. Maistre, Director (Agronomist)
Section Technique d'Application d'
Agriculture Tropical,
45 bis Ave. de la Belle Gabrielle,
Nogent-sur-Marne, Seine
France

15. Dr. Bouriquet, Pathologist
(address in #14)

16. M. Sagot, Inspecteur General
Direction de l'Agriculture,
Ministère de la France d'Outre-Mer,
27 Ave. Gudinot, Paris, France

17. M. Marcel Lagarde, Horticulturist
Paris, France (on vacation)
Director of station at Dschang, Cameroons

18. Dr. Branquinho d'Oliveira, Head
Pathologist
Estação Agronómica Nacional
Sacavem, Portugal

19. Mrs. Branquinho d'Oliveira, Pathologist
(address above)

20. Eng. Agrónomo Artur Medina, Chief of
Coffee Work in Angola
(Temporarily on vacation in Portugal)

21. Eng. Agr. Pereira Coutinho, Presidente
Junta de Exportação do Café,
R. Augusta 27, 3º Esq.
Lisbon, Portugal

22. Eng. Agr. José d'Orey, Director
Jardin Colonial
Belem - Lisbon, Portugal

List of Key Men (con't.)

23. Ag. Eng. Francisco Monteiro Grilo,
Praça Principe Real 13,
Lisbon, Portugal

24. Dr. Ralph Phillips,
Food and Agriculture Organization
of the United Nations,
Viale delle Terme di Caracalla,
Rome, Italy

25. Dr. Tom Ritchey
(address above)

26. Dr. Kirk
(address above)

27. Dr. R. Innis
(address above)

28. Dr. Linn
(address above)

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

[redacted] No. 2.

Brazzaville
August 12, 1952

TO: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Department of Agriculture

FROM: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

SUBJECT: Continuation of the World Coffee Mission - French Cameroun Report

Travel Interval

The vast continent of Africa lay below, bathed in moonlight, as the great airliner roared into action and winged its way from Europe to our destination of call in the Dark Continent. I detected a sense of expectancy throughout the two large cabins of that great airship as the steady hum of the craft took us straight south from Rome over the Libyan Desert and the Sahara. Every seat was filled, and Cowgill and I had to sit farthest to the rear with the upright backs of our chairs solidly against the cabin wall. Some passengers were going home to different parts of Africa.

It was possible to catch three naps that night, but I could not sleep for long. I was tired from the swift grind of Europe, but there was no comfort in the place I sat. Most of all, I kept reviewing in my mind the purposes of our trip. The preliminaries were all complete and we were finally plunging off into the work, out to places where we would see new sights and acquaint ourselves with new problems. Perhaps more than all was the hope that we would see top scientists of Africa and Oriental Tropics. There, I felt, was something for which I had wished for many years. And felt that I knew I would encounter friendliness, helpfulness, and a community of feeling with those specialists, no matter what their language or their training. We were to see researchers, and research is done by men who must engage in solitary and quiet thinking. With exception of only a few, they all have a bond of absorbing interest in the answering of the question, "Why?", and then placing their findings on the altar of use.

These musings were interrupted when lights were lit in the plane and the hostess placed a breakfast tray in our laps. I looked at Cowgill and he grinned

at me. We took a sip of coffee, turned to each other and almost simultaneously said, "Robusta flavor!"

Shortly after breakfast we alighted in Kano airport, a transit stop in Nigeria, where we were to change planes for Douala in the French Cameroun. Men who surveyed us as we came to the airport were black skinned, in flowing white robes and red fezzes. They were courteous and helpful. Dutch employees of the KLM airline put us into rooms of the nearby KLM guest house. The airport was some distance from Kano, and at first we made plans to hire a car and go into the village to see the palace of the Emir, the Mosque, and the market place, but we cancelled the ideas. Instead we took a short walk, saw a few camels, and read a few signs, one of which forbade exportation of big game trophies, and one prohibited exporting rhinoceros horns or rhinoceros horn powder. I went back to my room, wrote a few letters, ate two meals, and slept the day and that night.

Here we were, our feet on Africa.

French Cameroun: August 4 to 11, 1952

The "Cameroons" were at one time a German possession. Allied expeditionary forces won it from the Kaiser's forces in the First World War and it was put under the League of Nations, mandated to England and France. England handles a small northwest part of the old "Cameroons", and the French work with the rest. These Camerouns are under two quite different systems. It is too soon to say which is best.

This part of the world took its name from a great volcanic massif. There were several sections of the "Cameroons" split apart by geography and inter-tribal wars of the inhabitants. With statesmanship, winning of the Africans away from old tribal differences, the coming of world commerce, and the start of education, a change was wrought and they are gradually taking their place among modern countries.

The portion of this country in which we were interested was in the soil regions effected by volcanic deposits. It is broken country, and in the lower parts the soils are red to reddish brown. They become darker to black as you go farther up. We found Robusta (Canephora) coffees in the lower soils and Arabica in the higher. Those sections of the country we saw were impressively covered with palm, both planted and wild, in the more moist parts. The high shoulders and sides of volcanoes and small extinct volcanic piles have suffered annually from fire. Although there is evidence that these parts were once richly forested, they are now grasslands and difficult to put under permanent cultivation, especially coffee, because of the vigor of grass growth and the African's habit of burning. This will become a more serious problem as agriculture advances, and it will have to be worked upon by all of the institutions of the country.

While in the French Cameroun we visited the following institutions:

1. Agricultural Division of the Colonial Office in Douala. (Douala is commercial capital.)
2. Station du Quinquina at Dschang.

3. Centre Climatique Cooperative Planteurs Cafe at Dshang.
4. John Holt and Co. Nkongsamba.
5. Agricultural Research Station and Offices, Nkongsamba.
6. The office of the Governor at Dshang, and in addition a number of progressive plantations.

Our purpose in these visits was, of course, to work with coffee specialists and to see coffee. It was of interest to learn that some of the first work on coffee was started by Germans. However, it became important only during the last two decades when the French began an expansion program with both indigenes and European planters. This has been to fill some of the increased European demand. The country produces for export in some quantity such crops as cinchona bark, bananas, palm nuts and oil, coco beans, and coffee. It was estimated that this year French Camerouns shipped about 9,000 tons of coffee "oro". Next year the crop will be about 12,000 tons of which one to two thousand is Arabica coffee and the rest Robusta.

It can be seen that coffee is becoming of increasing importance, and we know that one of the problems in production was disease. Hemileia coffeicola, the second species of coffee rust, was described from here in 1934 and I was anxious to see a little of it. This, also, was the first time we had had a chance to see plantations of coffee since we left Central America. We looked forward to seeing the trees like one does to seeing old friends.

We were impatient to start, and I made contacts with Mr. Sutton of the John Holt Company. He is English and represents American interests, and he was indeed most helpful, taking us to the chief agricultural officer in the Cameroun. M. Frontou gave us much background of the work in progress. He had heard from Paris about us and was prepared. He then made an itinerary for us and furnished us with driver and government car. The car deserves special mention. It was a Willys Jeep pick-up, just new, ready for its first shakedown voyage. The words "shake down" are worth noting. On the windshield was the decalcomania-attached escutcheon of the U. S. A. and on it was this statement, "STRENGTH FOR THE FREE WORLD/from the/United States of America". The driver was proud of the car, and so were we.

The next morning we left early, with feelings of awe of the city of Douala after we paid the bill at the hotel and looked at our per diem allowance list. We began with a trip in rain and mud and road holes, going to the village of Nkongsamba to see coffee growing there. It is in the important coffee (Robusta) area. Nearby is a wide upland valley (elevation about 550 meters), formed by a prehistoric lake, and is known as the place of the Mbo people. It contains a large amount of Robusta plantings, some quite old. When we stopped in the first field, Cowgill stepped to a tree I was looking over for Colletotrichum injuries, and turning over the leaves said, "Here you are, Fritz. Your friend, Hemileia vastatrix!" From that time on, I didn't see any more anthracnosis. We found this Hemileia all over the fields. Some plants were more severely attacked, had many more spots, than others. In no case did those well cared-for Robusta trees appear specially injured by rust. Symptoms were studied and collections made. I did not recall any report in literature of occurrence of H. vastatrix so close to the Atlantic Coast in West Africa.

Return to Nkongsamba was late as we were accompanied by the Agricultural station pedologist who works on soils throughout all the Cameroun, and he knew several planters. The following morning we visited the nearby agricultural station with a collection of coffees that were planted in 1933. The soil looked good, elevation was 860 meters, average temperature was about 22° C., and they have a six months wet season and we were in the next to the last month of it. I found rust on trees in this collection. Those with H. vastatrix as follows (their names): Arnoldiana, Robusta, Congensis, Excelsa, Canaphora, Uganda 208, Uganda 5, Robusta 72-0, Robusta 78, Robusta 119, and Robusta 105-03. No rust was found on Quillou or Canephora purpurescens. I did not get to see all the plants because of rain and weeds.

Our next stop was after several hours and many kilometers of rugged roads and rain. The place was the Station Quinquina combined with the Centre Climatique Cooperative Cafe on the edge of Dshang. It is high in the hills. Here we saw demonstration plantings of Arabica and Laurina coffees. I found on these plants my first sight of what is described as Hemileia coffeicola. Both rusts were present, and in quantity doing serious damage. The two rusts occurred on the same leaf, symptons remaining as distinct when thus mixed as when they occurred alone. From sympton studies I am convinced of the separability of H. coffeicola from H. vastatrix. We went out from the Stations and visited much of the Arabica coffee district. Plantations of Europeans and the Indigenes were about equally covered with the two rusts. Defoliation was estimated at from 20 to 80 percent in unsprayed, poorly kept plantings.

For the native, his coffee is a cash crop and secondary. Living is from mandioc, dasheen, ground nuts, mealies, and small eggplants grown between the trees. The Hemileias exact severe losses under these conditions. In some cases Hemileia is well controlled by fertilizing the coffee trees and applying "occasional" sprays of Bordeaux mixture when the disease builds up too greatly. There are two or three breaks in the rainy season when spraying can be done effectively. Even in sprayed fields, I still found the rusts, but it was much more severe in unsprayed, weak plantings. The lands are much flatter than where we ordinarily grow coffee in Central America, and little shade is used. It was clearly notable that with even heavy infections with Hemileia, shade grown Arabica and Laurina coffee kept its leaves much better than sun grown trees. Coffee is ordinarily pruned to a single strong stem, and topped about shoulder high. Suckers are removed, and a comparatively thin foliage maintained. This adds to ease of spraying. Knapsack sprayers are used by negro growers, but narrow built Hardie and Bean rigs are used by Europeans. (We saw Bean sprayers with the mark of the United States effort as a part of the European Recovery Program.)

Spraying is not alone for the Hemileia rusts in coffee. Perhaps the most anxiety we noted was with regard to a large borer that works in the coffee tree trunks, a smaller borer that runs its tunnels into the bearing side branches, and the bug antestia that lives on the fruits as they approach maturity. The growers include insecticides with their Bordeaux sprays, and in one place we could smell BHC, which they assured us was "HCH". The Colletotrichum dieback and fruit drop is common, as are occasional trees attacked by the Pink disease, and I found a few fruits rotted by Cercospera

and a few leaf spots caused by that organism. In the Mbo region, more complaints were voiced about damage from elephants trampling coffee than for any other reason except borers.

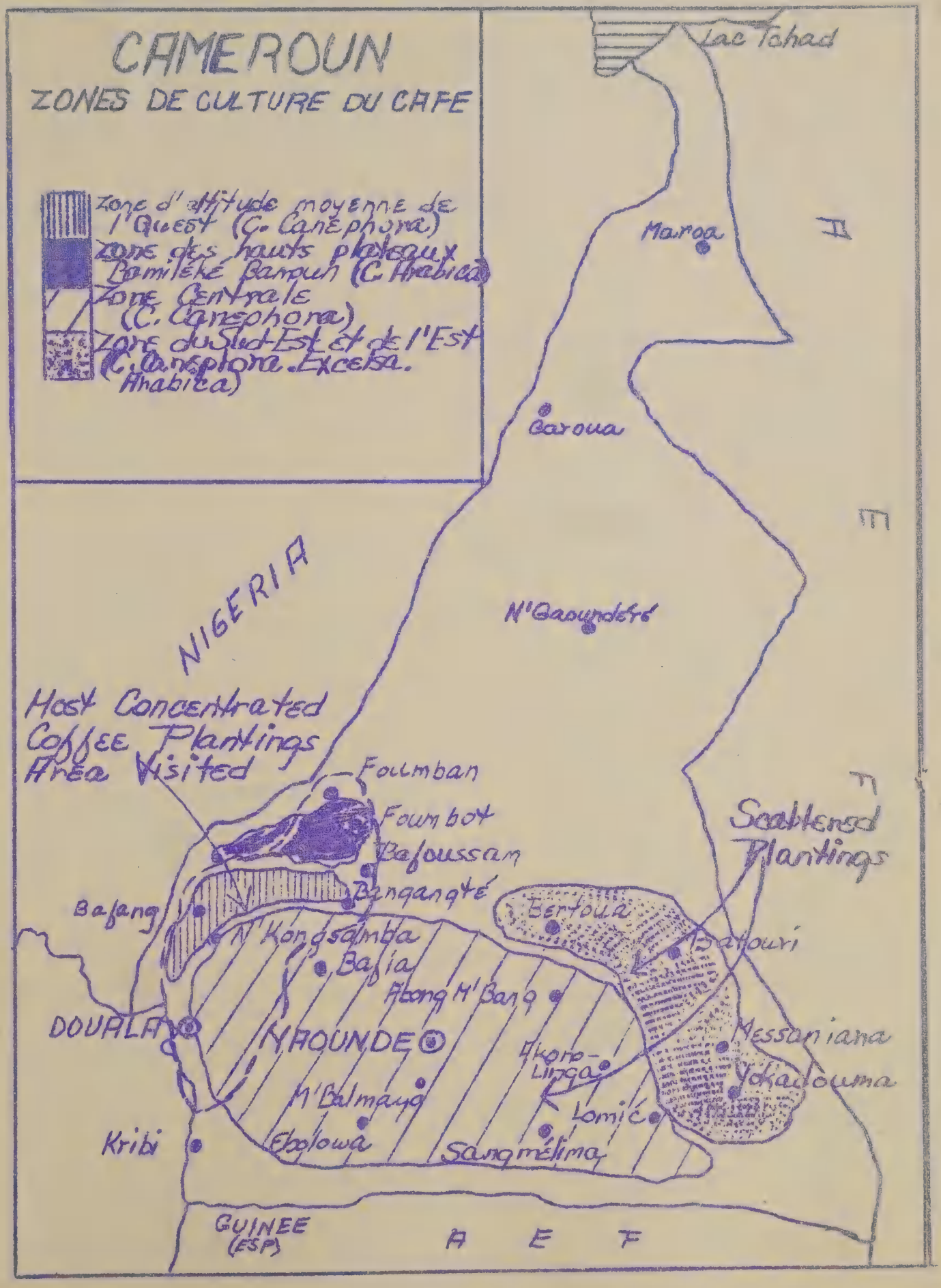
As Cowgill went from field to field, and in the collections at the experiment stations, he searched for coffee types that differ from those now available in Latin America, but with little success. He found, however, a planting of coffee called "Bourbon", the seeds of which were reported to have come from the Island of Reunion. This was in an experiment station planting at Dshang, and the plant characteristics were close to Laurina (which we called it) but sufficiently different from what Cowgill knows, that arrangements were made to have seed sent to the Plant Quarantine officials in Washington, when fruits were ripe.

List of Important Individuals Conferred with in French Cameroun

1. J. H. D. Sutton, c/o John Holt Co., Douala
2. A. C. Davis, c/o John Holt Co., Nkongsamba
3. M. Frontou, Inspecteur General Agriculture, Douala
4. M. Risson, Directeur, Station Quinquina, Dshang
5. M. De Lapersonne, Pedologist, Station Agricole, Nkongsamba
6. M. Bosseaux, Chef de Secteur, Nkongsamba (Station Agricole)
7. M. Picco, Chef Secteur Agricole, Foumban
8. M. Trolliet, Planter
9. M. Beaumatin

Conclusion

The French Cameroun stop was rewarding. We felt that we had really gotten into Africa. We saw it, ate of it, smelled it. I had my baptism of fire with respect to Hemileia rusts in the field. Our last night we stayed again in Douala, boarded the plane that following morning to cross the equator in Africa, and were ready for our next work scheduled in Angola.


CAMEROUN
ZONES DE CULTURE DU CAFE
Zone d'altitude moyenne de l'Ouest (C. Canéphora)
Zone des hauts plateaux Bamiléké Bamoun (C. Arabica)
Zone Centrale (C. Canephora)
Zone du Sud-Est et de l'Est (C. Canephora. Excelsa. Arabica)
Lac Tchad
Maroua
Garoua
NIGERIA
N'Gaoundéré
Most Concentrated Coffee Plantings Area Visited
Foumban
Foumbot
Bafoussam
Bangangté
Bafang
Scattered Plantings
Bertoua
Batouri
N'Kongsamba
Bafia
Abong M'Bang
DOUALA
YAOUNDE
Akoko-Linga
Messaniana
Yokadouma
M'Balmayo
Lomié
Kribi
Ebolowa
Sangmélima
GUINEE (ESP)
A E F

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

No. 3

Luanda
August 26, 1952

To: Claud L. Horn, Head, Research Development Division, OFAR, United States Department of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

Subject: Continuation of the World Coffee Mission - Report on Angola, August 13 to 27, 1952

Introduction

The river Nile is the most renowned stream in all Africa. But in the main, Egypt, of ancient history, the desert, and romance, is not the Africa of the of the Blackman. When one speaks of the Congo River, there is immediately brought to mind the equatorial part of the Dark Continent, the uncultured indigenous Negroes, and it is out of the realm of mummified remains. It flows through the center of, presumably, one of the most impressively old but undeveloped and evolving agricultural regions of the world. It seemed fitting to me as we left the French Cameroun that, on our way to Angola, we should have to cross the Congo. We did this in a launch heavily loaded with chattering blacks, and I felt conspicuous as a white. It was a short hop by plane from Leopoldville on the banks of the River, to Luanda in Angola where we arrived late in the afternoon of August 13.

We were met at the airport, which is wholly commercial in its organization, by the U. S. Consul, Mr. Elmer E. Yelton. Much had already been done through his services to smooth our way. We were taken through customs and immigration authorities quickly. A delegation of scientists were also there to meet us. This included Eng. Mesquitela, Agronomist; Eng. Ferrão, Entomologist, and Eng. Noronha, Pathologist, all of the technical service of the coffee production and export association of Angola. It was late by the time we had reached the hotel. After two swift drinks the technicians informed us that they had prepared an itinerary for our employment the days we were in Angola. This they showed to us, and then told us they wished to start at five o'clock the next morning. And, to be sure, it was not until we were many kilometers from Luanda the next day that the sun broke upon us driving eastward to the interior. We had a tough Dodge station wagon to take us, and the windows were

cloud. In spite of the low elevation, and our nearness to the equator, the air was sharp with chill.

Wherever we traveled on the low coastal regions, that day or any others, the soils we saw were sandy gray often underlaid with red, and flat with slight undulations. The grass and bush was blackened and still smoking with fires. The dominant spectacle was the hosts of fantastic Baobab trees (Addansonia) with their tremendous, squat, elephant-like boles. They were crowned by frantically reaching, short, slender branches, with large and elongated velvet-covered fruits hung onto them with short ropes. They were leafless, and the colors were bronze and olive drab. A painting of them could only be justly treated by an artist with the combined geniuses of a Walt Disney and an Arthur Rackham. Over it all hung the pall of clouds and smoke. As one passed the people of the country it was forcibly borne to him that there was objective reason to know it as the Dark Continent.

Roads were mostly good, said to be passable in all weather, deep in dust as we went by, and hard built of sand and soft rock. As a trip takes you into the hills, soils change from gray and brown to reds. The mother rocks from which they came push up their rounded shoulders of granitic make-up, worn into curves by the elements. River beds are grooved in beds of solid stone, and the blue waters of the dry season could be seen dashing along them rapidly down to the Ocean. None of the coffee regions we visited were of apparent newer volcanic origin. They varied in altitude from low places almost at sea level to mountain sides and high plateaus several hundred meters high.

Institutions Visited and Importance of Coffee

Coffee production problems are being investigated in Angola by agricultural technicians from Portugal and from the colony. The Junta de Exportação do Café Colonial has an organized technical service, and we visited two of its stations. Another visit was to the 44 year old station of the colony, Station Nacional Agronomica, at Villa Salazar. There was also a central experiment station of the Companie Angolana Du Agricultura (CADA). The offices and laboratory of the technicians of the Junta de Café were visited in Luanda. It is of interest that a new research station is soon to be established near Uige in the Congo area. This was the one coffee region that was not visited because of scattered small holdings, poor roads, and that we could see more in the places we did visit. Our trip covered something more than 1900 kilometers by road and nearly two hours of airplane travel.

There are a few farmers who are carrying on some trials on coffee tree handling cultivation, shade and other problems. These farmers are all Europeans, as there are but few native African coffee growers. The main research effort at present in Angola is on coffee, although various church missions in a few areas are carrying on demonstration and advisory agricultural services with the indigenous agricultural population. I was told that a forestry service had recently been formed in the Colony, but coffee holds the center of the stage. Around 47 percent of Angola's exportation this last year was coffee, and the prospects are for a larger crop this year. Coffee has been grown here since before the beginning of this century. A line drawn on the map roughly enclosing the areas in which coffee is grown, includes an impressive portion

of the colony. Since about 1925 the coffee growing region has expanded greatly in extent. In 1951 all Angola exported 64,432 metric tons of coffee, a record for the colony. New plantings are being made, more are planned, and in the next few years this crop will be of even greater significance to Angola. It was plain to see on our trip that coffee has its limitations as to adaptability, but it may well be that many of the colonists newly arriving from Portugal have been attracted because of coffee developments in this Colony.

Hemileia Coffee Rust Disease Situation

It is accepted as fact, and said repeatedly, that the greatest of all hazards to growing coffee in plantations anywhere in the world is the possible presence or introduction of the dread rust disease, caused by Hemileia. This is a consuming fear of coffee men. It is of great interest to note that Jannsen, who visited Angola sometime between 1925 and 1930, published in his report on coffee (Jannsen, Paul. Le Cafe Robusta dans l'Angola. Etude publiés par le Bulletin Agricole du Congo Belge. pp. 112, 1930 cf. p. 69 and 70) that Hemileia vastatrix is a most dangerous trouble, and gave recommendations for its control. Some people have considered that this report indicated the presence of the disease. However, Jannsen specifically states that he did not encounter the disease, but that its presence could be confused with Cercospora.

The pathologist for Angola, Eng. Noronha has been watching for Hemileia there for four years and has not seen it. He studied both literature and herbarium material of the trouble during his period of training in Portugal. He has likewise spent over a month in the Island of Santa Tome observing the two forms of the disease, caused by both Hemileia vastatrix and H. coffeicola, in company with his professor of pathology, Dr. Branquino d'Oliviera of Sacavem, Portugal. I am also acquainted with both forms of rust from literature, from herbarium specimens seen in the United States, England, and Portugal, and from greenhouse-produced growing rust lesions seen in Portugal and from field appearance in the recent work trip in French Cameroun. Cowgill is also familiar with symptoms of Hemileia attack. None of us found it in Angola.

Continuous watch was kept for coffee Hemileia on our trip in this Portuguese Colony. We examined literally thousands of coffee trees in hundreds of widely different locations. The reason for its absence is not exactly clear to us at this time. There is much still unknown about the environmental requirements to produce the disease. However, as for rusts in general they are of common occurrence in areas where we worked on coffee. These latter rusts were according to our observations and reports those that occur on wheat (the two common species), on peaches, on figs, on castor bean, on gladiolus, on Strophanthus, and as well on several species of weeds.

Other Coffee Diseases and Pests

The most important disease of coffee in Angola at present is that known as mort subita ("sudden death"), of which the exact causal agent is still to be determined. It is being studied. In works of Sacca and Stayert, what is believed to be the same trouble was connected with a soil inhabiting, root infecting Fusarium (perfect stage Gibberella xylarioides.) In Angola, mort subita may attack plants of all ages. It is most awesome in an older good producing plantation, where it kills bearing trees. It spreads slowly year after year in ever widening circles on flat land, but on hillsides goes more

rapidly downwards than to the sides so that an elliptical shaped spot of disease results. After leaf yellowing, plants die in 3 to 10 days, and if pruned no suckers are formed. Cortex of tree trunks is darkened, and streaks of brown can be seen in this part. It is very much different from the so-called mal de quatro Ano in Brazil, or the maya (Rosellinia) and the podre dumbre negro (Pellicularia) of Central America which also kill large trees by attacking at the roots.

Apparently the Robusta (Canephora) coffee is a highly susceptible variety. I found it succumbing near Villa Salazar, while plantings of Arabica both Bourbon and Typica and as well Laurina were plainly still healthy with Robusta dying on all sides. Annual losses are very high, and average from 10 to 40 percent in some farms. Control methods used thus far are of imperical nature. Trees are removed and used for fire wood. After a while new holes are dug and treated with lime and sometimes other materials. They are replanted, and where shade has been encouraged some of the replanted areas have remained healthy for quite a period. In some cases young replants have been attacked rather quickly after being put in the old diseased soil. This whole problem was discussed at some length with the pathologist, and methods of investigation were reviewed with him. It is a most interesting disease.

In Robusta coffee leaf spotting by Cercospora is found, but it causes no serious effects. Cercospora causes severe defoliation in Bourbon coffee but little or no injury to Typica. A yellowish cleared spot occurs, that might be suggestive of Hemileia, except that careful examination discloses its algal agent. Colletotrichum dieback is of slight importance on Robusta and typical leaf lesions may be found rather sparingly. On Arabicas, however, it causes more dieback, and its worst effect is attack of fruit peduncles causing very commonly 20 to 40 percent of drop of immature berries. It seems to me that this Colletotrichum works differently from that I know in the Americas. It may be another species or strain of the organism. It is much more serious on Bourbon than on Typica coffee.

Insect pests are said to be much more serious than diseases. The entomologist Ferrão is surveying the insect population of coffee, and has found some 90 species attacking the crop. Greatest losses come from Antestia orbitalis var. facets. This pentatomid feeds on flowers, buds, young fruits, and kills tender growing tips causing poor fruit set, excess fruit drop, weakened foliage, and abnormal production of side shoots on fruiting branches. The fruit and seed borer Stephanoderes hampei is probably next in importance. An excessive amount of laborious hand picking of grains is most generally required to obtain first class export grade coffee. The large trunk borer Dirradus sierricola is severe nearly everywhere, as is Apate monachus and Anthores leuconotus. The smaller fruiting branch borer Xyleborus sp. is another serious pest. All of these present very difficult problems of control. Thrips sp., are likewise common, and are especially injurious in unshaded plantings. They may cause severe defoliation in Arabica Typica, but practically none on Bourbon in sungrown coffee. Antestia, by the way, required shade for its most vigorous and successful development.

Monkeys, which travel in droves, several of which we observed, cause considerable destruction of coffee at times. They pull plants in seed beds and nurseries, apparently for the pure mischief of it, and often eat and pull off to waste much ripe fruit.

Methods of Growing Coffee

In Angola there is apparently nothing much in the line of established traditional practice in methods of coffee growing as we understand it in the Americas. It is a comparatively new crop, growers have come in from many different backgrounds, and they have much variation in ideas about spacing and other treatments. The works of the Brazilians has had much recent and favorable influence on experimentation by agronomists on Angola coffee problems. The writings of Dr. Carles Krug and his associates at Campinas, Brazil, are well known in Angola and some of the coffee technicians have studied in Brazil. Many of them speak with great satisfaction and respect about the help received from last years visit from Eng. Teixeira Mendes, Agronomist, and Eng. Ataulfo Ferreira de Sousa, Plant Introduction Specialist, of the Instituto Agronomico in Campinas, Brazil. The Angolan workers are making much progress in organizing research studies, and in taking advantage of observations to be made on coffee under many different conditions.

Both the Robusta and the two Arabica varieties are grown at various altitudes (Arabica is largely in higher land areas), in various types and colors of soils, and on the surface, in several places, they both seem to be producing about equally well either with or without shade. In some instances growers assert that they have the best production in the plantings grown without shade. Others have imported such shade trees as Albizzia and Grevillea, or have left the original forest cover under which to grow coffee. Spacing of coffee is at various distances, but on the whole within the expected, such as is found in the American Tropics. Clean culture is often practiced, and is common in regions of serious fire hazards. Sometimes clean culture may be of benefit on account of low soil moisture content. In other cases weeds are allowed to grow between the trees but kept cut close to the ground level to eliminate soil erosion. This is also given as the reason for making most elaborate benches and terraces in some plantings. Sometimes holes are dug in rotation around the trees to "conserve moisture," and also to "add humus." Mulching is being studied as a possible practice of value in some of the dry locations. However, its tinder-like qualities add a great danger in the burning season, where they cannot control fire ing by the indigenous neighbors. These are in the habit of burning off the bush in the hills to drive off insects and frighten away dangerous animals from their home surroundings, for which they cannot be blamed. But it is a sobering problem, and one which must eventually be solved by education and regulation, and other government assistance.

Observations are being gathered by agronomists of the Colony on effects of variable coffee growing methods carried on by different growers. Field plots have also been laid out to study these things in a scientific manner. It is to be noted at this point that Cowgill was questioned many times with regard to his ideas about these things, and about what he was doing in Central and South America. He discussed his ideas and his experimental methods and results freely. He gave the technicians much food for thought and it is believed that some of his suggestions will be found incorporated in the future research programs on coffee growing in Angola. This part of Africa is very close to the equator where the sun is traditionally considered to be excessively dangerous to man and also to delicate plants, the dry season is prolonged and severe, and the soils are relatively poor and do not seem to be greatly retentive of moisture. Still, from what I saw I could not convince myself that there appeared

to be any advantage to growing either Robusta or Arabian coffees under shade. If good differences could be found it seemed to me that the dry season in which the observations were made would exaggerate and make even more clear those differences.

The scientifically determined results that should be secured by workers in Angola will give answers to many of these perplexing questions. These answers should be secured in a few years to guide future changes in coffee production methods for the country.

Coffee Plant Materials Secured

All the time while in Angola, Cowgill kept a continuous watch to see if there were any differences in the types of coffee grown there in comparison with what is grown in the American Tropics. It appears that commercial production comes from varieties of coffee well known in both Hemispheres. In fact, some of the material has come to Angola from improved strains developed in Brazil. However, Cowgill did discover and secure some materials of considerable interest, as follows: 1. Cuttings from a Rubiaceous tree, probably a near relative of coffee, said to be of spontaneous occurrence in this country. 2. Seeds were also obtained from the same tree. 3 and 4. He likewise obtained three plants each of well hardened seedlings of two strains of a wild coffee, Coffea racemosa, that originally came from Mozambique. From descriptions and herbarium materials Cowgill encountered in Europe this would seem to be something entirely new for study in Tropical America. 5. He has also requested more seeds to be sent to him from Mozambique of this coffee and some others. 6. He obtained seeds of the F2s of the famous Brazilian variety known as "387". 7. He has been promised more seeds of this variety as it is grown in Angola. 8. A strain of what appears to be a different type of Laurina coffee was found growing near Villa Salazar, and seeds from this have been promised to Cowgill when the fruits have ripened.

Miscellaneous Remarks

Certain facts about work now in progress in the Angola experiment stations visited may be of some interest here. The National Agronomy Station is located at an elevation of about 615 meters, surrounded by thinly forested country. It was started 44 years ago but was abandoned until seven years ago when it was revived. The most important contribution it is making is as a botanical garden and demonstrating the possibilitiesof growing tropical crops not ordinarily found in Angola. The soils are grey brown in color, and irrigation is available to keep certain crops going during the dry season. There are collections of such crops as the following: 1. Rubber plants. Old plantings of Hevea and Castilloa, and in addition some lesser known types. Latex is taken and processed into sheet rubber for comparative demonstrations. 2. A number of spice and contiment plants. Their useful products are prepared for observation. Such plants include black pepper, cinnamon, vanilla, mints, and others. 3. A few coffee demonstrations and selections. Some 46,000 individual plant records are being kept. 4. Some work has been done on oil palms, and at present individual production records are being kept on 3,000 trees. 5. There is a collection of shade and wood trees. 6. Fiber plants, from which fiber is extracted for demonstration, include such as Urena lobata, several Hibiscuses including Kenaf, species of Sida, and Abroma. 7. A collection of 49 different bananas

has been assembled. These are being studied for comparative yields. 8. A number of different forage and legume plants are also growing for observations. 9. Exotic as well as common vegetables are also being grown and observed. 10. Many different ornamentals are likewise being maintained.

The large Companie Angola Du Agricultura has a station in the hills, at an elevation of about 1000 meters. The station is said to cover about 40 hectares of hillside plantings, all in coffee experiments. It is in the center of the Robusta coffee growing area. Their studies are less than two years old and may be listed as follows: 1. Studies on varieties and selections. 2. Fertilization, both materials and methods of application. 3. Planting distances and spacing studies. 4. Planting practices, such as number of plants to a hole, and depth of planting. 5. Methods of rooting coffee cuttings. 6. Spraying to control insects. 7. Shade studies, including amount used and species of trees most adaptable. 8. Control of the disease mort subita. 9. Work on a few miscellaneous crops helping coffee planters. Where applicable all field studies are handled in randomized blocks of 100 trees each, replicated four times. As far as possible, variables are handled in simple fashion.

The Posto du Fomento du Ambion, a station of the Junta de Cafe, has an elevation of about 940 meters. It covers 80 hectares. Occasional frosts occur there, on the Benguela Plateau. The soil is predominantly gray in color. Field experiments that may be thus treated are laid out in randomized blocks, of 100 trees each, replicated four times. The following studies were seen: 1. Spacing experiments. 2. Number of plants per hole. 3. Methods of planting. 4. Number of branches maintained per plant. 5. Shade studies. 6. Variety comparisons. 7. Breeding and selection work. 8. Fertilization studies. 9. Cultivation studies. This Posto was started in 1947 but many plantings are less then two years old. It is not only a research center but is as well a training ground for young colonists wishing to become coffee growers.

The Junto de Cafe has a second station near Chicuma, in the center of the Arabica coffee growing region. The soil is gray, but shallow and under laid by red subsoils. There are 50 hectares in the station, and the elevation is over 1700 meters. Here also field work is laid out in a systematic manner, looking forward to future statistical analysis. The original plantation on which this Posto is built is about 20 years old. By far the largest area is in new experimental plantation. We were shown studies on the following: 1. Variety trials. 2. Methods of planting. 3. Spacing. 4. Numbers of trees per hole. 5. Pruning practice. 6. Disease studies. 7. Insect studies. 8. Methods of renovation. 9. Fertilization practices. 10. Irrigation. 11. Mulching studies. 12. Plans have been made for processing studies.

List of Most Important Technicians Encountered and Consulted

1. Eng. Durico Noronha, Pathologist. Servicio Tecnica. Junto de Cafe. Main office - Luanda.
2. Eng. Antonio Ferrão, Entomologist. Servicio Tecnica. Junto de Cafe. Main office - Luanda.
   These two men traveled with us all over the country.
3. Eng. João Carlos Mesquitela, Junto de Cafe, in charge of the work of the Junto services in the absence of Sr. Arthur Medina.

4. Engº. Oliveira. In charge of Posto du Fomento du Ambion.
5. Engº. Americo Fraçata, Agronomist, in charge of the Station Nacional Agronomica, Villa Salazar.
6. Engº. Pereira Caldas, Gerente, Station of CADA, near Gabela.
7. Engº. Ruy Theumdo, Inspecteur de Cafe. CADA
8. Engº. Antonio Mendes de Ponte, Agronomist, in charge, Posto du Fomento, Chicuma.
9. Sr. Edvardo de Oliveira, Administrador, CADA. Roca Monte Alta

In addition many planters were met and consulted. These were all Europeans of Protuguese, German, and Swiss blood.

Return to Montevideo

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No. 4

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To: Claud L. Horn, Head, Research Development Division, OFAR, United States Department of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

Subject: Continuation of the World Coffee Trip - Report on Belgian Congo, August 27 to September 10, 1952.

There is always something wierd and also something magical that comes to mind when one speaks of that great country of Africa called the Belgian Congo. In both poetry and song are the drums of the Congo, that still beat and throb in the green great wilderness. Historically, it is the land where the whiteman's conscience caught up with him, and where some of the first important stands against black slavery were made. Throughout the story of search in its jungles there threads the stupendous mapmaking and mankilling travels of Stanley and the superhuman explorations, endeavours, and geographical finds of the kind, tireless, and intrepid Livingstone. It is a hard man's world.

Geographically, the Belgian Congo encompasses practically all of the great Congo Basin. It spreads across the Equator, a long ways on both sides. It is low and hot some places, yes in large part, and not fit for much pleasant human habitation without great care. In some areas, however, it is a land delightful for anyone, and it extends in its greatest height to perpetual snow and ice. The country is large, almost a third the size of the United States; larger than a combination of Mexico and the Central American countries of Guatemala, Honduras, El Salvador, Costa Rica, Panama, and the Canal Zone thrown in. It extends from Africa's Atlantic Coast to the very center of the Continent. To make our trip we had to cross the Congo River five times, and we crossed the Equator three times.

Ethnologically, the Congo is, among other things, that land of the fabulous elephant-inhabited Ituri rain-forest, where pygmies live in their late stone age. On its last border rises the massif that leads to the Ruwenzori, the ancient Mountains of the Moon. On these slopes is an internationally respected gorilla sanctuary near Lake Kivu, where those near relatives of man are fully protected except from occasional bands of the pygmies bearing spears and mystical bits of forest magic. It is, indeed, from the forests of the pygmies that certain odd species of coffee have been obtained. Where the

jungle thins, there are other peoples. Open spaces of grass stretch up into the hills, and a race of cultured black-skinned people live there. They are the Wautusa Tribe that came down from the Egyptian Nile millenia ago. These are the remarkable "Giants" of Africa, often over seven feet tall, slender, long straight nosed, proud, and highly integrated in their own surroundings. They are populous, wearing dramatic robes of white painted in free unhampered designs reminiscent of some of the latest art of the Impressionist School of Europe and America. They worship the bull, as did Egypt, personified in their fantastically large-horned cattle that are their symbols of wealth and immortality.

There were several reasons for us needing and wishing to spend a little time visiting and studying coffee growing in the Congo. We know the region as a source of large leaved, heat adapted coffees variously named but known mostly in commerce as Robusta, and to scientific workers as Canephora. We wished also to see the growing of the high quality arabica coffee, in the mountainous regions. Another important reason for seeing coffee in the Congo was that the species Congensis comes from there, and Cowgill had noted that in the Americas there has been much controversy and mixing of information over this coffee. It may be of great value in the future and he wished to see it growing where it came from. There are many coffee diseases in the Congo, but two were of special interest. The "Tracheomycose", caused by a Fusarium and very serious, and the dreaded Hemileia rust. Neither of these occur in Tropical America. As important as any consideration was the fact that coffee work had been carried out on a scientific basis in the Congo for some decades, and we were anxious to meet the specialists, exchange ideas, and know them. We wished to become acquainted with the institution under which much study has progressed, the Institut Nationale pour l'Etude de l'Agriculture du Congo Belge (INEAC); with its main station at the low-land position in Yangambi, and the second large station, Mulungu, in the high land area of the Mitsumba Mountains. There are, altogether, over 20 INEAC stations in the Congo. Over 4 percent of the value of the Colonies' agricultural exports is used in the furthering of scientific agriculture for its inhabitants, both black and white.

Institutions Visited and Importance of Coffee

It can be well imagined that such a country as the Belgian Congo has had much scientific attention from expeditions out of Europe and North America. They have studied its unique facets of ethnology, tropical living and diseases of man and animals, its wide range of geological and soil problems from tropical to alpine, its rich fauna of protected wild animals, its birds, and its flora and insect inhabitants whose myriad aspects are fitfully under scientific surveillance. It is of note that Belgium considers this Colony one of the central projects in its economy, and the national institute for its agriculture (INEAC) was established in 1934 to combine and organize the work of many commissions and privately started institutions that had been working for years before. As was mentioned above, INEAC has over 20 stations, located in strategic areas, dealing always with problems of scientific agriculture.

The following institutions were visited and worked in, having conferences, seeing the work, and exchanging information:

1. The Office of the Directorate of Agriculture and Colonization, Leopoldville.

2. Offices, laboratories, warehouses, and shipping station of the Office of Robusta Coffee, Leopoldville.
3. The quasi-official shipping and importing firm of Belgika, Leopoldville.
4. Main national agricultural experiment station (INEAC), Yangambi.
5. Main national highlands agricultural experiment station (INEAC), Mulungu.
6. The new medical and animal disease and food study institutions just under construction, Institut Research Scientifique en Afrique Central (IRSAC), Kavumu. Yangambi has 20,000 hectares under demonstration and research, and 40,000 hectares of forest preserve. Mulungu has 506 hectares under research, and has recently added another 206 hectares. The IRSAC station has 155 hectares.

As we visited these institutions, we were able to secure information about the relative importance of coffee production to the Belgian Congo, and found it of significant stature. The largest agricultural export of the country is fibers (mostly from Urena lobata, interestingly enough); after that is oils and palm kernels, and third comes coffee. In 1950 the Colony exported over 323,000 bags (60 kilo.) of Robusta coffee, and about 234,000 bags of Arabica. Nearly 58,000 hectares of land are planted to Robusta, of which almost exactly 95 percent is grown by European planters. Of Arabica, the story is slightly different. About 39,000 hectares are planted, of which a little over 65 percent is grown by the indigenous black peasantry. It would have been interesting to investigate why the white planters were more partial to growing Robusta, as it is uniformly grown in the low hot regions where living may often be a trying experience; as compared with the highland growing of Arabica in the cool, more solubrious regions of the volcanic eastern part of the country. To the farmers, whether European or African, it appears that the future of coffee is bright. This is evident when it is realized that of the total coffee now growing, there are some 18,000 hectares newly planted, and over 5,000 hectares of newly planted Arabica. In going through the country, we also saw in many locations preparations for further plantings of both coffees. This seemed to us of special note as we knew that the Rust, known to be such a serious disease, occurs in the Colony. We reasoned, therefor, that much must have been done to perfect control measures for the disease or otherwise ameliorate the expected high losses from rust attack.

Hemileia Coffee Rust Disease Occurrence and Importance

One of the main purposes in coming to the Congo was to see the Hemileia rust as it occurs in this part of the African West Coast. The occurrence here suggests increasingly easier access by spores to the Western Hemisphere, through wind channels and stratosphere travel, and other natural means of spread. Also through accidental contaminations in movements by airplane traffic. On the very first coffee leaf I plucked in the Yangambi station, I found the truly handsome, round, orange-powdered lesions of Hemileia vastatrix. I found it scattered as a few spotted leaves almost everywhere. When I discussed it with the specialists they told me that they realized fully that nearly all plants had a few spots. However, on Robusta Coffee, it was practically of no importance. In fact, it was of such little moment to the growers that many of them, including a few trained specialists, did not even seem to know what the disease looked like, although their own fields were attacked. What leaf shedding on Robusta occurred from rust, they considered "natural" or at least "normal" under their conditions.

The conditions in and about Yangambi are interesting. First it is in jungle-covered territory, cut out of the bush. The 20,000 hectare area of the station in use is mostly tree crops, oil, palm, cacao, rubber, and coffee. Soils are sands of an old lake bed that, when it dried up, was moved about by winds some few millenia ago. The climate turned moist eventually, and it became a dwelling place for trees and was then covered with dense vegetation. The station is one degree north of the Equator; it is warm and is at an elevation of about 500 meters. At the time of my visit, moisture conditions were not good, as the dry season was just ending, but the rains which are necessary for vigorous development of rust had not really started.

Nevertheless, from what I observed the fungus did not seem to be spread in Yangambi with the ease that one would imagine for a rust. The spores are wind borne, and they report frequent winds in the station. I noted several quite old plantings of Robusta coffee that appeared free from rust. Within a few hundred yards were other Robusta plantings with fairly liberal amounts of disease, and the jungle trees in the strips between the healthy and diseased fields were quite open, forming no serious wind obstacle. I found rust in a nursery of cuttings planted in woven baskets. These had been growing several months, but it was reasonably well confined to clones that had apparently been contaminated at planting time. I found old lesions on old original leaves of these diseased clones. Young leaves were severely spotted. In a few instances slight spread had occurred in closely adjacent plants of originally healthy clones. Watering was done by bucket and sprinkling can, and workers were walking around and between these plants. These are, of course, observations over a very short period. Further study might tell a quite different story. Also, it must be remembered that I was dealing with the more tolerant Robusta coffee variety.

There were other varieties of coffee grown in Yangambi and I examined them there for rust attack. A list of what I observed is as follows:

1. The common strain of Robusta is varied in its severity of injury. Rust defoliation may be from 3 to about 20 percent.
2. Liberica seemed mostly rust free. A few trees showed scattered lesions, but I saw no defoliation that I could blame on rust.
3. A few Arabica types, other than the common Arabica, were seen, and they all were badly diseased.
4. The field of what had been an experimental plot of typical Arabica was visited. There must have been over a hundred plants in the original area. Of these, only two were left and they were badly diseased and could not last much longer. It seemed fair to me to blame death of all those Arabica trees on Hemileia rust.
5. A Camphora-like strain called "Congensis from dry land" was seen, and it was free from the disease.
6. Another variety of so-called Congensis "from moist lands" that more nearly resembled an Arabica type was seen and was also found to be free from Hemileia.
7. A "wild Angola" variety was seen, without Hemileia.
8. Canuga coffee was also healthy.
9. Many special lines of selected Robusta were observed, and none were found strikingly free or strikingly susceptible in reaction.
10. An unnamed Rubiaceous bush, very close to coffee, showed no rust.
11. A second unnamed Rubiaceae was also found free from the disease.
12. Ten wild Robusta plants in the jungle were found free from rust; probably escape.

The situation in the highlands was of equal interest. In Mulungu Station, where I made the most careful notes, the rains had just commenced and coffee was in flower. Elevation at the main buildings was about 1700 meters, and Arabica coffee grows from 1600 to 2075 in the area. At below 1600, rust destroys it and at above 1850, the temperatures are so low that production is uneconomical, but rust exists there up to the highest limit. Rainfall is 1.5 to 2.0 meters, soil is a dark volcanic deposit, and the main cultures being studied there are quinine, tea, pyrethrum, certain medicinals and coffee. I found coffee severely rust attached, defoliation about 80 percent, at the edge of Lake Kivu where it is at 1640 meters elevation. I was also impressed with instances of apparent "difficulties" of spread of the disease in this region. While in general all Arabica coffee had Hemileia, there were a few somewhat isolated plantings growing in which I found no sign of its attack. The area is subject to winds, and there was free access by workers to these disease-free plantings. In one instance, a one-year-old nursery planting of coffee was observed free from attack, with a plot of older diseased plants only 21 meters distant. There was, moreover, little to obstruct free passage of wind between these plots.

In Mulungu Station there is a fairly large collection of coffees, and as I saw them I examined them for rust, with the following results. Hemileia was common on: 1. All standard varieties of Arabica; 2. A "Wild Arabica", and on all special strains such as, 3. "yellow", 4. Typica, 5. Local Bronze, 6. Bourbon, 7. Myson, 8. Moka, 9. Jackson, 10. Kent, 11. Geisha, 12. Blue Mountain, 13. Catuvia, 14. Santiago, 15. Porto Rico, 16. Bullata, 17. San Ramon, and was especially severe on 18. Harar, 19. Amphillo also showed considerable rust as did, 20. A number of Robusta strains, although they appeared quite tolerant, 21. A common Liberica was seen with a few spots, but, 22. The "Liberica from Luberu" seemed free, 23. Eugenioides from Rioka had no Hemileia, whereas, 24. Eugenioides from Astrida had a few spots, 25. Coffee Congensis, "river land type" showed no Hemileia, neither did, 26. Kawassari, 27. Kivuensis from Mount Kahuri was also apparently free.

Observations I had made on effects of altitude on Coffee Rust corroborate those of Hendrickx, who is the Senior mycologist and pathologist of INEAC, and Director of Mulungu Station. He has studied it for years, along the Equator in the Belgian Congo and Ruanda-Urandi. I also collected and observed it in the latter territory. He finds it serious at sea level to about 1600 meters on the mountain slopes. From this up to 1850 is the best band for Arabica coffee, although the trouble is common. He has found the rust on coffee growing as high as 2450 meters, and I found it myself at 2075. There, however, plants were growing very slowly and leaf spots were not numerous. On the whole the variety plantings at Mulungu were in the altitude band in which Hemileia was serious but not extremely severe.

It must be remembered in connection with my observations on attack of Hemileia on coffee that the plantings were scattered and not in designed experiments to test resistance and susceptibility. My records are, therefore, somewhat superficial and actually largely suggestive rather than definitive. It is for precisely this reason that they are not presented in tabulor form. But it can be seen that the rust is more effective as a parasite on some coffees than on others.

There are a number of other rusts of the same genus (Hemileia) as that on coffee in the Congo. Hendrickx (see his Sylloge Fungorum Congensium, publ. INEAC, Series 35, pp. 216, 1948) reported the following species: helvola on an undetermined

Rubiaceae, laurentii on a rubiaceous host, Schultzii on a Clerodendron, and vastatrix on Arabica and Canephora coffee, and on Coffea myrtifolia and C. laurentii. In addition he told me he was prepared to include a species attacking an Allophyllus, and two others on two undetermined Rubiaceae. It should be pointed out here that I obtained for my own collections on this trip, Hemileia in lowland plantings of the Congo on Strophanthes hispida and S. surmentosa. The conditions are apparently good for rusts in general in the Congo. Hendrickx lists 192 species, comprising 26 genera under 4 families.

It is my opinion that as the Congo develops its coffee business more intensively, the Hemileia rust will have to be restudied with respect to its actual damage. The application of control measures and use of resistant varieties should greatly extend the areas in which Arabica can be grown. At the present time other pests and diseases are absorbing practically all of the energies of entomologists and pathologists of the Colony.

Other Coffee Diseases, and Insect Pests

The disease of coffee being given major attention in the Congo Basin is the "Tracheomycose", caused by Gibberella xylorioides. This Fusarium attacks Excelsa (Liberica) and Robusta (Canephora) coffees in the lowlands. Severe losses are being sustained in over 15,000 hectares of the country. It was first found in 1949 in Yangambi and Dr. Fraselle developed an eradication program based on his studies that now has the disease under control. I observed the trouble and studied its symptoms and have concluded that it is different from the "mort subita" of Angola, the "Mal de Quatra Anos" of Brazil, the Fusarium disease of Porto Rico, or the wilt and stunting disease (Fusarium) that I have been working on in Costa Rica and other Central American countries. Briefly, Tracheomycose is apparently carried about through the air by insects or wind-borne spores; it spreads to widely reported individual trees; it may enter aerial as well as root tissues; the organism spornlates readily on external host tissues either as the conidia or ascospore stage; it usually causes a unilateral infection resulting first in wilt and death of a few side branches commonly in the top of the tree; a broad, somewhat lignified, black ribbon of vascular strands leads up the main stem from the point of infection to the group of dead laterals; and it can be controlled by efficient early diagnosis and an on the spot elimination procedure, first spraying the diseased tree with an oil spray, then digging, chopping up and allowing to dry, and then burning in the hole from which it was dug. Replanting problems are being studied.

There are other less important diseases. Koleroga occurs but is not common. Cercospora leaf spot is severe in nurseries, especially in Arabica regions. But plants recover with increasing age, and as they become established in the field. Those leaf spots are almost non-existent in old plantation coffee. An algal leaf spot is found, but it is of little importance except as it may be mistaken for Hemileia attack by an inexperienced observer. Colletotrichum is a serious disease organism on Arabica coffee, causing dieback and fruit drop. This has been controlled by an intricate pruning program for dieback, and fruit drop resistance in special strains of "Local Bronze" Arabicas. Nematospora Coryli has been found in fruits, occasionally causing quite substantial losses. It can be readily controlled by insecticidal applications to eliminate the insect vectors, Antestia, two species of Lygus, and a Volummus. Arsenic "intoxication" symptoms cause confusion at times after spraying for insects, but this leaf crumpling can be easily eliminated by using arsenic free insect poisons. The berry borer, Stephanoderes, is often encountered. It is mostly kept in check by the fungus Beauveria sp.,

and other enemies. Stem and trunk borers are found but in minor numbers. Some symptoms of what I considered typical zinc deficiency were seen on some old Robusta trees. In the highest regions where Arabica grows I was fortunate in observing the necrotic spots, leaf crumple, shortened internodes, and dwarfing of trees to make them conical in shape, due to excessive variation in temperatures. This comes about in unshaded coffee where the nights are cold followed by hot days, the famous "hot and cold" disease. Shade reduces the shock of extreme temperature changes.

Methods of Growing Coffee

To a plant pathologist, the method of growing coffee in the highlands, is adapted to disease control and amelioration of losses in Arabica from attack. Shading is recommended, and it does reduce injury from "hot and cold" and from Rust. The elevation at which Arabica is grown also appears to take these troubles under consideration. Clean cultivation is often practiced, which "increases the vigor of the trees, and assists in reducing Hemileia." Where possible, the weed-clean soil is covered with mulch, and in many cases no shade is planted which eliminates occurrence of algal leaf spot. Where shade is used the best trees are a strong growing strain of Leucena glauca and the indigenous Erythrina abysinica. The "three-stage pruning" on a single stem, reduces dieback, and holds the coffee trees to a moderate fruitfulness thus reducing susceptibility to rust attack.

In lowland growing of Robusta, there appears to be an unconscious elimination of Arabica, because of extreme disease from rust. The system used to grow Robusta, whether consciously adapted to this purpose or not, could have well developed to reduce injury from diseases such as Koleroga, Cercorpora, and the accumulation of mosses and lichens that may be seen so prevalent in the undergrowth of jungle areas. Robusta is very often unshaded, in clean cultivated plantations. It is pruned to multiple stems, with new supply stems kept coming up to replace the old ones that become worn out after a period of fruit bearing. In Yangambi and Mulungu, long time studies are in progress to test shade growing against non-shade growing. Of a number of shade trees tried from Indonesia and elsewhere in Yangambi, the most satisfactory have been two obtained from the local flora, Philanthus discoiides and Croton moubanga. The latter is the first choice, giving in 5 years a manageable shade, withstanding much trimming and producing a medium light umbrella of protection of what the specialists consider almost ideal proportions.

As soon as results from growing studies are obtained that appear useful, they are taken out and applied on farms (shambas) in the affected regions. Both Europeans and the indigenous Africans grow coffee. The negroes are made through strict measures to follow very carefully the rule-of-thumb instructions that are given to them. The indigenous farmers grow from 50 to 90 trees each, sometimes in very scattered plantings, sometimes drawn together in more solid groups, depending upon how the community operates and how the Chief of the tribe runs his domain. European shambas, or plantings, are large. Their operations, carried out by negro labor, are wholesale and are based on the information from the Government (INEAC) technicians.

It may be of interest here to note that while agricultural research has been in progress in the Congo since about 1905, and it was drawn together under organized more highly intergrated programs by the establishment of INEAC in 1934, they do not have a full fledged nor a far flung extension service. This is evolving slowly, on a very strong base. They have believed that with the resources at

hand research must come first, developing a firm body of locally learned knowledge, over a well extended period. Meanwhile, they use agronomists, who are researchers as well, to teach new methods and answer questions. The technicians consider that they gain much in these first decades of establishment of scientific agriculture, through their more intimate contacts with the growers and with the problems that arise. Both in Yangambi and in Mulungu experiment stations, it was found that surrounding growers had made much use of the work of the stations. It was seen, as well, in regions quite far removed from experimental studies. Research workers did an adequate amount of traveling, and the result was that they not only could keep well abreast of new problems, but they could take advantage of what was found in the fields at distances from their own plots. One of the results has been the testing of local plant materials encountered.

3. coffee relative Psilanthopsis kapakata, from Mulungu thirteen coffees, 4. kyrar

Plant Materials Obtained and Promised, and Collection of Herbarium Specimens

When we stopped in Belgium, preparatory to coming to the Belgian Congo and the trust territory Ruanda-Urundi, we discussed the matters of interchange of scientific information and plant materials. This discussion was much welcomed by the Director General, Dr. F. Jurion. He gave me lists of publications, and we presented him with our selections of the titles represented, which he then said would be sent to Washington. He has had continuing good contacts with our libraries in the United States, and in parts of Latin America through the help of the U. S. Department of Agriculture. When we discussed securing of plant materials, Dr. Jurion explained to us that some embarrassment had been experienced at times because of foreign contacts, especially with private concerns wishing seeds, medicinal materials, and plants, and it was now requisite that permission be obtained by the technicians before they sent away materials. He promised us, however, that there would be absolutely no difficulty in our case and asked us to suggest what we might send to the Congo from the Western Hemisphere, while we were visiting the INEAC stations. This was specially carried out by Dr. Cowgill.

They told us in Yangambi and Mulungu that they would be glad to send us what we wished, and knew of Dr. Jurion's promise, but still required written word on the exact lists we presented to comply with Government formula. Cowgill, in the meanwhile had sent Jurion a list of the coffee variety and species and selections that he wished for us, and left lists in both Yangambi and Mulungu stations. Lists are as follows: From Yangambi - 1. Coffee Congensis (river type), 2. Coffee "petit spontanee," 5. Eugenioides, 6. Eugenioides from Nioka, 7. Eugenioides (?) from Astrida, 8. Mysore Arabica, 9. Geisha Arabica, 10. Jackson Arabica, 11. hybrid Arabica and Libenca, Kawisan, 12. Local Bronze "8", 13. Local Bronze "9", 14. Local Bronze "12", 15. Coffee Congensis, and 16. Coffee Kivuensis. In addition, seeds of 17. Erythrina orophila, 18. Leucena glauca, strong growing strain, 19. Solanum micrantha, 20. Rubus pinnatus, and 21. Rubus rigidus were actually secured and sent to Washington.

While in the different countries studying the coffee disease problems, I have taken advantage of the opportunity to secure preserved herbarium specimens for what use might be made of them in connection with our own work in the Western Hemisphere. I have not listed what I secured in Portugal, Nigeria, Cameroun, or Angola. These should be mentioned for the record. In Portugal I was given specimens of Hemileia vastatrix and H. coffeicola by Dr. B. d'Oliviera, from materials he had collected in Sao Tome, both on Arabica coffee. In addition, he gave me specimens

of liberica coffee, showing H. vastatrix, but which is, according to d'Oliviera, resistant to coffeicola. In Kano, Nigeria, I found what appeared as a possible rust on an unidentified shade tree. In the Camerouns I collected and preserved the following: Robusta with H. vastatrix - 2 collections; Laurina coffee with H. coffeicola - 2 collections; Arabica coffee with coffeicola - 1 collection; and leaves with combined infection of both vastatrix and coffeicola - 4 collections; and an annual Composite with rust on it under badly rusted Arabica coffee. In Angola I found no rust, but obtained on coffee: 1 collection of algal leaf spot, 1 of cercospora leaf spot, 1 of "mort subita", and 1 of bleached coffee leaves thought due to a mineral deficiency. In the Belgian Congo I obtained on coffee: 2 collections of H. vastatrix on Robusta, 6 collections of H. vastatrix on Arabica, and 1 collection of these markedly porositized with other fungi, Strophanthes sumentosa 2 collections with Hemileia, and 1 collection of the rust on Strophanthes hispida, 1 collection of a Gardenia leaf spot, tea Pestalozzia, 1 collection, 1 collection of Koleroga on Robusta, 1 collection of virus-like effect on Robusta, 1 collection of rust (?) of Dissotis grandiflora, coffee Eugenioides 1 collection of Antestia feeding effect, and 1 collection of "hot and cold disease." In Uranda Irundi I obtained 2 collections of H. vastatrix on Arabica coffee. This is a total of 42 collections, from 6 countries.

Miscellaneous Remarks

Although this period spent in the Congo was primarily to deal with coffee, we saw a number of other crops growing and observed a few things about them. It is impossible to do a great deal on any of the other crops with the short time we have had at our disposal, as we concentrated on coffee. However, we noted in Yangambi that in addition to coffee the Institute (INEAC) is carrying on basic studies in a number of fields. One is meterology, another is soils, a plant physiologist is studying not only fertility problems but water relationships in the root zone, there is some entomological work in progress on certain jungle inhabiting insects, and like matters. In addition to coffee, their main crops for study are oil palm, cacao, and rubber as this is in the lowlands. The cacao work is well along but relatively dry conditions are not conducive to large production. Selections are being made for strains better adapted to the Congo Basin. They are also looking for other Theobroma species to study that problem, and we have requested material sent to them from South America, through the Office of Foreign Agricultural Relations. It is well known that INEAC has accomplished much in work on oil palm. Their selection and breeding program has resulted in synthesis of strains of exceptionally high yielding trees, that are all fertile. It was of great interest to find that rubber was a rather large culture in certain parts. Rubber and Robusta coffee are often grown together. We drove through many kilometers of jungle along the banks of the Congo, and saw many rubber plantations. Some were just being planted, some were slightly older, and some had been under production for a large number of years. At Yangambi Station, they have a large plantation of rubber in production through which they study numerous practical problems. They have many of the high yielding Eastern clones in their plantings and they are selecting clones of their own, from breeding programs for adaptation to rather marginal conditions of soils and climate. They expect in a few more years to have material that will eventually supplant even the best Eastern Clones. Incidentially, I observed Hevea rubber for the first time being attacked by Loranths. There were two species of the parasite on rubber, and I have never seen any of the rubber in the many Central and South American countries where I have observed it that was attacked by any of our American Loranthaciae.

When we arrived at the highlands station at Mulungu we found that in addition to coffee their greatest interests were in quinine, tea, pyrethrum, and medicinal crops including those producing essential oils, Cinchona was every place in the mountains of that region. Many years of very profitable breeding and horticulture have gone on at Mulungu on this crop. There were many very large commercial plantings, and these were altogether of strains of Ledgeriana. There is a Belgian quinine exporting firm in Costermansville, in the Congo. While the present outlook is not too satisfactory for the immediate future, everyone seems to feel optimistic about the years ahead. I saw plantations from very old to some just starting and new seed-beds as well. Tea is a developing culture, and the flavor of Kivu Tea that comes from this region is a pleasant, soft, and distinct one. It is gradually being looked upon as of greater and greater importance and its planting is expanding rapidly. It has few diseases or insect enemies. Tea is being studied, and selected at Mulungu for flavor, production, adaptability to the region, and for suitability for horticultural purposes. Before the last war, pyrethrum had been a profitable business in the Kivu highlands. Farmers increased their plantings, and INEAC's Mulungu technicians kept pace with problems and developments. At about the time Mulungu was at its best in pyrethrum work, new fungicides were being developed, and some word came from Europe to stop all that work. The test tube magic killers were certain to replace the plant extract. The change in emphasis was duly made at Mulungu, but with characteristic conservatism the breeders preserved their best strains out of sight. They believed there still was hope for those productions. Farmers meanwhile stopped growing the crop, and it nearly disappeared. It was soon evident, however, that the synthetic wonder poisons had their limitations. There is now a great resurgence in pyrethrum culture and research, and the best of efforts are being put into improved seed. This is bred for disease resistance, high pyrethrim content, suitability for harvest, and other good horticultural qualities. It is a reestablished crop for the Colony.

The leaders of agricultural research in the Congo show a stimulating anxiety about the progress of their efforts. It was evident that they believed that any advancement whatsoever was dependent first of all on research.

List of Most Important Individuals Met and Conferred With
. (not including U.S. State Department personnel)

1. Mr. G. Sladden, Directeur General de l' Agriculture. Cabinet du Secretaire General. Kalina, Leopoldville.
2. Mr. L. Theuwissen, Directeur Colonisation et Offices. Kalina, Leopoldville.
3. Mr. J. Collignon, Directeur Adjoint, Office du Cafe Robusta, Leopoldville.
4. Mr. Heraly, Colonisation et Offices, Kalina, Leopoldville.
5. Dr. F. Thirion, Chef du Division du Cafe et Cacaiero de l' Ineac, Yangambi.
6. Mr. J. Henry, Sub Directeur, Ineac Station, Yangambi.
7. Dr. M. Lecompte, Directeur General en Afrique, Ineac, Yangambi.
8. Dr. E. Frasselle, Pathologist, Ineac, Yangambi.
9. Dr. A. Ringoet, Physiologist, Ineac, Yangambi.
10. Mr. Pagacz, Assistant du Cafe, Ineac, Yangambi.
11. Dr. F. L. Hendrickx, Pathologist and Director, Ineac, Mulungu.
12. Dr. F. Lefevre, Entomologist, Chef du Phytopathology et Sub-Director, Ineac, Mulungu.
13. Dr. Vandenberg, Director (animal pathologist), Irsac, Kavumu.
14. Mlle. Kanner, Secretary, Irsac, Kavumu.
15. Kayonga Max, Interpreter and Secretary (Wautusa Tribesman), Irsac, Kavumu.
16. Mr. Gay, Selectionist in Coffee and Cinchona, Ineac, Mulungu.
17. Mr. Snook, Assistant Selectionist, Ineac, Mulungu.

(Note all mail to the Ineac station in Yangambi is usually addressed "via Leopoldville", and all mail to the Ineac station in Mulungu is usually addressed "via Costermansville")

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

Fifth Report No. 5

Nairobi, September 29, 1952

To: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Dept. of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

Subject: Continuation of the World Coffee Trip -- Uganda Report, Sept. 10-12, 15-17, 1952

The country of Uganda is located in East Central Africa between the east edge of the Congo River basin and the highlands of Kenya. It is relatively small as countries go in Africa. In square miles it is about the size of Great Britain and North Ireland. It covers about the same area as one of our larger Central American countries, Nicaragua, is twice the size of Guatemala and three times that of Costa Rica.

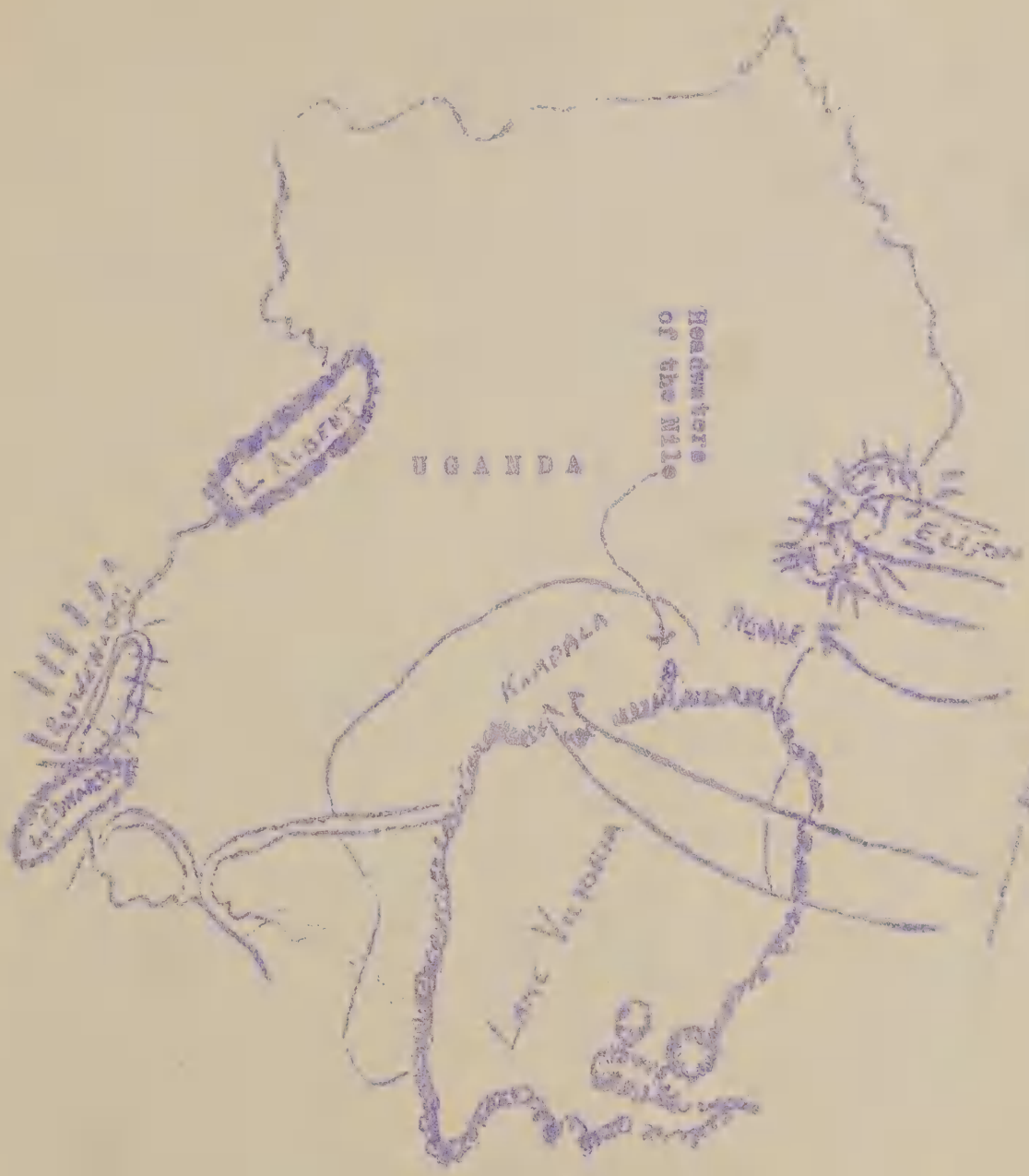
Towards the west leading in the direction of the Ruwenzori Range, it is a fly ridden scrub. Much of it is a land of rolling hills clothed with thin soils, quite dry, and relatively grim for habitation by men. Adjacent to the Ruanda-Urundi, in the northern highlands, in the higher regions about the Ruwenzori uplift, and on the shoulders and talus-built slopes of volcanic Mount Elgon there are pleasant places to live, and these are more densely populated.

The great landmarks of the country are snow capped Mt. Elgon, roughly half included in Uganda, Lake Victoria whose northernmost port is included and which is the headquarters of the Nile, and the Ruwenzori Range, called in old books "The Mountains of the Moon," and topped by Mt. Stanley. This mountain mass rises 16,794 feet above sea level and was at one time believed to be the source of the Nile, until John Hanning Speke showed Lake Victoria as its mother, back in 1862.

In many ways it is an attractive country, to which have gone explorers, adventurers, and colonial workers and administrators from England since those earliest days. There are about five million Africans in the country, and nearly forty thousand Asiatics and Europeans. It has been administered as a Protectorate since 1893 under the British, who have carried on a consistent policy of assisting the Africans to evolve and develop themselves.

There are some 20,000 acres of land owned by Europeans, but it is now a law that Africans can not sell land to non-Africans. Over 167,000 acres are cultivated by Africans, of which over 15,000 acres alone are producing coffee under the famous Bugishu Coffee Scheme (for natives). This is increasing at a rate of approximately 15 percent annually.

SUDAN



BELGIAN CONGO

KENYA

Arabica Coffee region

Robusta Coffee

RUANDA

URUNDI

Institutions Visited and Importance of Coffee

Uganda is the tenth largest producer of coffee in the world. Its largest exportation is cotton, but coffee is next. Anyone knows that coffee is not an easily grown crop. In Uganda methods of solving difficulties have often been based upon the experience of intelligent growers. As Coffee has developed into a larger agricultural business and the greater concentration of growing plants of a single production, it brought with it its usual questions and problems. Many were solved by following advice secured from research workers in neighboring countries, and there was also the establishment of some research work in Kawanda and Bugishu region.

We visited the following: 1. The Kawanda Station, 2. the Bugishu Coffee Scheme Offices, 3. the Protectorate's important agricultural offices in Mebale, 4. the curing and shipping center of the Bugishu Coffee Scheme production in Bubolo, 5. The Bugusege Coffee Planting station where agronomic trials are carried on, and 6. the Directorate of Agriculture in Entebbe.

The Bugishu Coffee Scheme of Uganda is one of the potent reasons that this country looms so large in world coffee production. In 1950-51, Uganda sent into market from the Bugishu Scheme alone 3,200 tons of arabica coffee, and 750 tons from other growers in the country. This is largely from the Mt. Elgon region. Robusta coffee comes mostly from the lowlands, and in that same year Uganda marketed 32,250 tons of this coffee type from native growers, and some 300 tons of non-African grown Robusta. While the prospects are for a larger total coffee production this current year, it is believed that the higher priced Arabica will be about 12 percent less. It is believed by Agricultural Officers that Robusta is more suited to production by Africans. It is a more vigorous tree, and does not require the more delicate handling given Arabica coffee by Uganda growers. It seems possible, to the outside observer at least, that the presence of Hemileia rust, and its effect on the more susceptible Arabica may be an important contributing cause to this turn of affairs.

Hemileia Coffee Rust Disease Situation

We had much discussion about the greater severity of Hemileia in Uganda when we were talking with technicians in the Belgian Congo, and other parts of West and West Central Africa. These almost invariably said that the trouble was of lesser to no consequence in their parts, but we would see more of it in Uganda. They considered that it was of increasing importance the farther east it was found. Perhaps both Cowgill and I came to Africa with an excess sensitivity to the ravages of rust. We were, in any case, completely unprepared for the thought expressed by some workers in West Africa that

Hemileia was not an unmixed evil. It even acted as a defoliant at proper times taking away leaves and preparing the coffee trees, by reducing growth, to cope with the severe dry seasons that occur!

Indeed, when we visited the Kawanda station the first impression was that Hemileia was truly of minor importance to coffee growing in that region. The first plantings visited were Robusta, and while all trees had a few more or less seriously spotted leaves still attached to them, only moderate defoliation was evident. Even when we saw that, we could not easily concur in the belief that the disease was not of great concern. The technicians in Kawanda felt the same as we did. When we went to the Arabica coffee plantings in the station they were found to be in dire straits. They were weak, terribly defoliated, about 90 percent leaf loss and many still attached leaves badly attacked, and the foliage was poorly colored. This station has an elevation of 1196 meters (3924 ft.) is almost exactly on the Equator, 0°25' north, has an average rainfall of about 43 inches, and average temperatures ranging from 84°F to 58°. Such conditions seemed, therefore, to be rather excellent for rust development on Arabica coffee. At the same time previous observations in other places that Robusta was highly tolerant of the trouble were readily confirmed in this location.

We visited the Kawanda collection of coffee species and selections to observe others than what we had seen, for susceptibility to rust. A large number of lines and regional types of the Robusta group were examined, looked very much alike, and all were about equally tolerant, with the exception of one called Canephora ruwenzorii, that was apparently markedly more susceptible than the usual run of Robustas. With respect to Arabicas, in every case all types were so severely diseased that they seemed all to be equally uninteresting as possible sources of resistance in that species.

I then observed the Hemileia disease in some detail at the Bugusege Station, elevation 1463 meters (4800 ft.), and found there the disease to be quite serious. In general trees seemed about 40 percent defoliated, and often leaf-fall was closer to 80 percent. On going uphill the defoliation appeared progressively less. At 1700 meters (5600 ft.) Hemileia was everywhere present, but causing a minimum of damage, probably less than 5 percent defoliation.

I secured no exact figures about Arabica production at the different altitudes. In early days coffee was grown at around 1100 meters. Now, however, it had been practically abandoned, or Arabica had been removed and Robusta replaced it. Arabica is a continued fair crop at around 1500 meters in spite of the well recognized presence of the rust; and I believe that even at this altitude the growers were sustaining serious losses. No one

had ever made an attempt to see what coffee grown without Hemileia could produce. At 1700 meters, although coffee was much less attacked by the rust, the yield was somewhat reduced due, presumably, to lower temperatures and slower growth of the Arabica trees.

There were some suggestive details regarding effects of Hemileia that came out of discussions about the Bugishu Coffee Scheme. This is a cooperative arrangement, fostered and in a manner imposed on the African grower. It was put into effect to bolster and increase a somewhat failing production. Through the Scheme the African is protected against the at one time large number of unscrupulous practices and unethical buyers and shippers. The work that led towards the Scheme started in 1931. There are now 19 pulpers and regulated native buyers who handle the crop. The hope is that the Scheme will produce some 6000 tons of Arabica coffee per year. However, the Africans are bringing in less and less of this high quality coffee, in spite of the fact that new seed beds are planted and their productions distributed free of charge each year. It seems probable to me that disease can be the basic reason for this condition of affairs. It needs study.

While this reduction has been going on with Arabica coffee, the Robusta market is being better and better supplied. The Africans have found it much easier to produce. On many European estates it has replaced Arabica. My feeling is that this is due to increasing intensity of Hemileia effects on Arabica, while Robusta's greater tolerance to the disease makes the coffee grower turn naturally towards its production, so long as it is acceptable to the market.

Other Diseases and Insects of Coffee

There is not a great deal of pathological or entomological investigation on coffee in progress in Uganda at this time. Determinations have been made, and the problems are known. Information about troubles and control measures are largely drawn from Colonial Service Research Stations in Tanganyika and Kenya. Practical applications of findings are tested in Uganda by Agricultural Officers before they are generally recommended for use by growers. But some things arise that are unique.

Some interesting cases of what appears to be a virus disease, at least virus-like in symptoms, were found under study in Kawanda on Robusta coffee. It occurs in two areas, and one of these is on the station grounds. Leaves are crumpled into almost a rugose condition, stem internodes are shortened giving a dwarfed appearance, side shoots develop, and under certain conditions somewhat of an indistinct mottle marks the leaf lamina. The trouble is spreading slowly and is causing some alarm among the technicians. Little or nothing has been said about it in public. Several attempts have been

unsuccessfully made to transfer the disease by ordinary artificial methods of inoculation used as standard practices with plant viruses. Grafts have also been tried, but the unthrifty conditions of the diseased tissues have not given good results and the unions have always failed. This brings to mind that a ring spot, which the Uganda disease does not appear to be, has been reported years ago in Brazil by Bitancourt. Also that d'Oliviera showed me in Portugal dried specimens of an apparent virus trouble on coffee in Sao Tome. My superficial judgment would be that the Uganda disease differs from both of these, and is probably in the yellows group (if it proves to be a virus!).

A trouble not unique to Uganda deserves special mention. They have some serious difficulties with the Coffee Berry Disease (a strain of Glomerella cingulata), that they uniformly call "CBD." Strains of a vigorous Arabica type with bronze tip leaves have been introduced that are highly tolerant to the trouble.

Coffee is likewise attacked by several insect pests. These are much more serious than any insect troubles I have ever seen in Tropical America. The worst of these troubles is Antestia. The white stem borer (Anthorea leuconotus), the black stem borers (Apate indistincta and A. monacha), and the yellow beaded stem borer (Diaphya principe) are all reported from this country. They are the most serious in old coffee shambas, Stephanoderes, the berry-borer also occurs in some places and in quantity.

Some spraying is carried on in a minor way to control both Hemileia and the CBD. Insecticides are used as well in some instances. However, more faith is put in cultural treatments to increase tree vigor and thus reduce losses from insects and diseases.

Methods of Growing Coffee

One of the things that Uganda horticulturists contend is that they do not want coffee of too vigorous a type. This leads to over bearing and subsequent weakness by exhaustion, that puts the plant into a more susceptible state for attack by both insects and diseases. The chief criticism of Kent's Arabica, a fine vigorous, heavy-bearing strain, is that it is too good!

All coffee is pruned, but especially Arabica. This is kept pruned heavily. The single stem system is quite popular in many cases. As the lower bearing side branches bear fruit they are pruned off before they die back. The result is tall whips of trees with the fruiting wood eventually formed in a bushy broom at the top. This was often propped up to keep it from breaking. After a few years a second shoot is encouraged to emerge from the base of the old whip; and it eventually takes the place of the former.

Clean cultivation is practiced, and the Africans are encouraged to use shade in their shambas or plantings. There were, however, many shambas without the protection of shade and they looked as if they were in about as good a condition as those with much sun protection. The lower the elevation of the shamba, on the other hand, the better seemed to be the effect of shade. This was, however, not true where dry conditions occurred where there was apparent struggle for available soil moisture between the shade and coffee trees. In some places this becomes a serious problem in the country of Uganda.

Coffee Plant Material Secured and Herbarium Specimens Collected

Of the coffee strains or species or varieties we saw, only one seemed to be of outstanding interest to us. All the others we have already in the Western Hemisphere, or have secured them from other places. The strain we found is the so-called "Barbuk Sudan." Seeds were secured in an isolated planting, and have been sent in to Washington.

With respect to preserved specimens of diseased material for herbarium study, I obtained 10 of what I considered interesting collections. Severe attacks of Hemileia on Arabica coffee are represented in five collections, and there is one collection illustrating the lesser attack on Kent's Arabica. Symptoms of a severe mineral deficiency on coffee were seen, and the affected leaves collected, and as well leaves were collected of Robusta attacked by an apparent virus. Specimens of a rust on a small Euphorbia, and a legume with spherical fungus fruiting bodies covering its leaf surfaces were also obtained.

List of the Most Important People Met
(This does not include any American Personnel)

1. Mr. T. Y. Watson, Director of Agriculture, Department of Agriculture, Entebbe
2. Mr. J. T. Moon, Acting Deputy Director of Agriculture, Department of Agriculture, Entebbe
3. Mr. J. D. Jameson, Agricultural Officer in Charge, and Plant Breeder, Kawanda Agricultural Experiment Station, Kampala.
4. Mr. A. S. Thomas, Plant Pathologist, Kawanda Agricultural Experiment Station, Kampala.
5. Mr. G. D. Badger, Agricultural Officer in Charge, Department of Agriculture, Mbale.
6. Mr. W. P. Beattie, Supt., South Bugishu District, Bugishu Coffee Scheme, Mbale.
7. Mr. R. G. Woods, Manager of Bugishu Coffee Scheme, Bugishu Coffee Scheme, Mbale.
8. Dr. M. Vasey (M.D.) Local practicioner, Mbale
9. Mr. Wambene, Native coffee buyer of the Bugishu Coffee Scheme.
10. Mr. Cahulio, Native coffee buyer of the Bugishu Coffee Scheme.
11. Native secretary in charge of field operations, Bugusege Coffee Planting Station, near Mbale.

Addendum

It should be recorded that on arrival in East Africa we were joined by Dr. Pierre Sylvain, Coffee specialist for FAO, stationed in Ethiopia. He came to become acquainted with coffee growing problems in East Africa, while we were here. This also serves to give note to the fact that both Cowgill and I have been appointed as collaborators on coffee with FAO while we are on this world trip.

/s/ Frederick L. Wellman

(6th Report)

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

[redacted]

No. 6.

Karachi
October 4, 1952

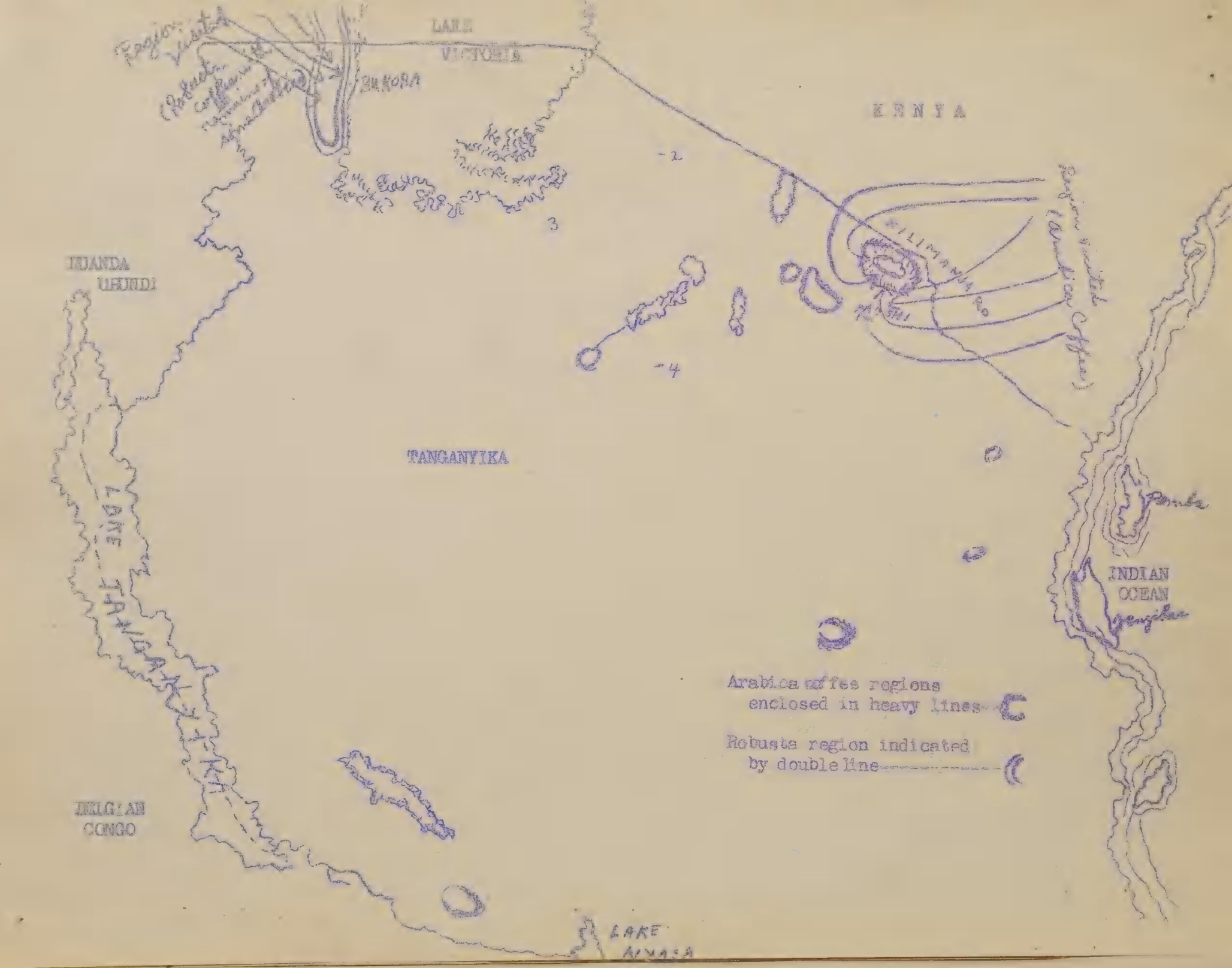
To: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Department of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

Subject: Continuation of the World Coffee Mission - Tanganyika Report, September 12 & 13; 23 to 27, 1952

The Science of Tropical Agriculture is slow in development, and some of the reasons are well exemplified in Tanganyika. The country is large, it has been spoken of as "almost a subcontinent" with reason, but more than that communications have not been good, and the distances are considerable between settlements. Since the advent of the airplane it is easier to go between certain main points, but the sense of Tanganyika's tracklessness is most impressive, and of its immensity of uninhabitable waste, except for a few very wild African tribes, lions, leopards, and big game. When a scientist volunteers to go to a post in such a country he is slipping into a certain amount of isolation, not only from any recognised center of scientific development, but also he is going to live in a considerable dilution of what he has thought of as civilization. There, it is difficult to secure some of the simple creature comforts, and the establishment of a semblance of the type of home which many scientists greatly require as refuge from days of trying work. Securing of scientific instruments, source of skilled assistance, exchange of materials for study, purchase of books and periodicals, and keeping fully abreast of rapid developments in science are at a great premium in the tropics; especially because of the lesser creative developments usually characteristic of such lands. Of Tanganyika this is all true.

German scientists, missionaries, rulers, adventurers, and businessmen, all came to Tanganyika towards the middle of the last century, as part of the wave of protest against the Slave Trade. The country became a protectorate under the German Imperial Charter of Protection in 1885, and in 1891 the first regular Governor was appointed to replace the old German East Africa Company rule. The country was managed with an iron hand, but they treated it also to scientific study until the advent of the 1914-18 World War, when all energy went into that conflict. Then, after some fighting it was taken by English troops under General Smuts. The English started right in where the Germans had left off. In 1946 it had been made an international trusteeship by United Nations Charter in the hands of British administrators. In the interim Tropical Science had gone on, and its


LAKE
VICTORIA
BUKOBA
KENYA
-2
3
KILIMANJARO
-4
RUANDA
URUNDI
TANGANYIKA
INDIAN
OCEAN
Arabica coffee regions
enclosed in heavy lines
Robusta region indicated
by double line
BELGIAN
CONGO
LAKE
NYASA

advancement in the Protectorate is with the Englishmen. The work must touch a large area, and this adds to the difficulties of selecting the most likely problems that must be studied.

The country covers nearly 367,000 square miles, with about 450 miles of coast-line on the Indian Ocean. It is influenced greatly from the Orient by the small and humble sailing craft that ply with the monsoon winds. Its history goes back to the days of the Arabian Nights and the fabulous voyages of Sinbad the Sailor. The central part of the country is a dry plateau, lying in equatorial heat at some 4000 feet above sea level. There are volcanoes, high flat lands up to 10,000 feet, low sun-baked coastal portions, mountains topped with snow and glaciers, and lakes and rivers, some of which have still not been exactly mapped. In the early days of the highly remunerative slave trade, Arabs charted routes and streams to transport their human cargoes that had been secured by the hunters of unscrupulous chiefs of the different regions. With the coming of the great discoverers and explorers, more exact knowledge was gained and recorded about the country, and this was further perfected by the German travellers, missionaries, and scientists. This is still being carried on by Americans, Englishmen, and other Europeans since British occupancy.

However, the Germans have left their mark, and their work is spoken of with respect by scientists in every part of the tropical world. We came to Tanganyika to take advantage of that older work, as well as the new. Although we did not have the time nor the travel facilities to go out to the original, still isolated and now being abandoned agricultural research center of Amani of the old Germans, we saw its effects. About all that is valuable of the German accomplishments are preserved and used. Much has been transferred to nearer Nairobi, in Kenya, and other parts to other institutions of Tanganyika.

Institutions Visited and Importance of Coffee

Our first visit in Tanganyika was (1) to the work in the region of Bukoba. Here an agronomic station for coffee was started this past year. We did not see its actual site, as time was short and the agricultural officer in charge assured us it was nothing but newly planted fields, and experimental work wholly on paper at the moment. After that we visited: (2) the Lyamungo Coffee Research Station near Moshi, (3) the Tanganyika Agricultural Department Office, (4) the Office of the Moshi Native Coffee Board, (5) the Offices and Buildings of the world renowned, and controversial, Kilimanjaro Native Cooperative Union, "KNCU," and (6) the offices and works of the quasi-Governmental, Tanganyika Coffee Curing Company.

Everywhere we went we were surrounded by the influence of Coffee. It is, of course, because of economics. But the Europeans and the Africans are making large use of it in the development of this country and the well started integration of African Peoples into the Greater Family of the world's whole. In 1950, Tanganyika exported a total of over a quarter million bags of coffee, of which over half was Arabica. Recent figures, for the 1951-52 season production of Arabica coffee in parchment, show that Europeans have sent to the hullers 2,871 tons and Africans 9,455. While Robusta coffee is the type mostly grown in the Bukoba area, it is even against the law to plant it in the Kilimanjaro region. This ordinance is given strict attention by the native coffee growers there.

But agriculturists produce other crops for export in the country. It is to be recalled that Tanganyika developed its sisal industry to a high degree under the leadership of the Germans, so that today it satisfies one-third of the world's market for this fiber. Also, although it is not advertised like Kimberley and other South African mines, Tanganyika boasts of the romantic Williamson Diamond Mine that is said to be the richest in the world, and that has kept the South African combine from having a total stranglehold on this mineral. The country produces other things, like wheat, hides, maize, and tea. But coffee is, of its agricultural exports, the second in value. From the standpoint of the development of the country and its indigenous peoples, it is probably the most important product. So it seems that the coffee research in the country, whether dealing with technical growing aspects, with extension practices, with economics, or with its sociological problems, it is of great significance. Also, it should be noted, that Tanganyika researchers do not live for this country alone. Uganda, for example, draws upon it to solve some of their coffee producing questions. Tanganyika students have also contributed scientific help and assistance to countries outside the British Commonwealth, notably the Belgian Congo. It became of special interest, then, for us to see what manner of work these research men were doing, and more particularly to see how they handled the problem of the Hemileia Rust on Coffee.

Hemileia Coffee Rust Disease Situation

It appears, from what I gathered after seeing the disease and talking to coffee workers, that the rust (Hemileia vastatrix) occurs wherever coffee is grown in Tanganyika. It has been known from early days, and has been a limiting factor for production of Arabica coffee. The Bukoba region is on the western side of Lake Victoria, has an elevation that averages about 1280 meters (4200 feet) and has approximately 75 inches of rain a year. I did not secure temperature figures, but as it is only a little over a degree south of the Equator with a large body of water, Lake Victoria, close by, it can be judged that it is both warm and moist. The altitude does, however, not, in itself, preclude growth of Arabica. Temperatures are not excessive, as European-built dwelling houses were seen with fireplaces, and the monsoon winds were said to not only assist with the sailing craft on the Ocean and Lake, but to also bring cool weather along with the rains.

Long before the dawn of written History, tribal chiefs along the west shores of Lake Victoria held the only right to own coffee trees. Those trees were said to be originally in the forest. We were taken to see some that were old, according to story, before the Germans first came. These "Chief's Trees" were of the Canephora species (Robusta of commerce). Their descendents have long been attacked in mild form by Hemileia. When Arabica coffee was first brought into this region it was widely planted and it bore well. After a few years, however, it "lost its capacity for heavy bearing," and now unless it is very specially tended it is certain to be killed by Hemileia attack. In spite of the higher price obtained, the growers have been forced to progressively give it up, to such an extent that it is now a very minor part of the Bukoba production. The agricultural officers are at present openly advising against Arabica planting, and are replacing the bad trees with Robusta seedlings. Even Robusta may be severely rusted in Bukoba nurseries, unless it is sprayed with a copper fungicide. There has been only minor effort given to spraying as a part of the general coffee

growing system by the Africans there. Hemileia is said to be practically absent during the dry season. When it starts raining there in August or September, it is said to "swoop in like a fire." Within 14 days after the first rains, it is reported that you could begin to find the first new rust spots. Heavy yielding trees one year are said to be most severely attacked the succeeding season. All this made the rust story a compact, neat, and logical matter.

When things regarding Hemileia were discussed in Lyamungu Station and in the Kilimanjaro region in general, my informants considered the situation to be fairly complex. This latter Station is at about the same altitude as Bukoba, and with about the same rainfall. It is a little over three degrees south of the Equator, and apparently somewhat cooler, but not a great deal. However, Arabica coffee is the main crop there. In fact, as I mentioned earlier, it is against agricultural ordinance to plant Robusta in the whole of the Kilimanjaro-Lyamungo region, except at the station itself where only a few trees are maintained for experimental purposes. Hemileia in these parts, operates in about the following fashion. Heavy leaf fall of rusted leaves occurs usually at the start of the dry season (June-July). Trees pass to a semi-dormant condition, and although they retain numbers of rusted leaves they are not in great evidence. Then come the rains. At the beginning there is no great rusting, but it increases and the new leaves are soon badly spotted. Sometimes these infected leaves are dropped within a very short while, but so long as moisture is sufficient new leaves develop and branches keep about three pairs of terminal leaves on until the rains slow down. Growth of the tree is reduced then, but at the same time so is the development and spread of Hemileia. In the end, if the conditions are right, the trees may produce a few more pairs of leaves before drought is so severe that this is no longer possible. One thing follows another, in the sequence just about as indicated. This cycle happens twice a year, as they have two rainy seasons, called the "Long Rains" and the "Short Rains" with distinct dry seasons intervening. With a fair cover of shade, leaves hang onto the coffee trees longer than without protection. Coffee grown with grass around it is more seriously attacked than that which has been kept free from this class of weed.

As I have been observing Hemileia on coffee I have noted considerable differences in size of spots. At first I thought it might be due to strain differences in the fungus. I have since become convinced that, in part at least, it may be due to ecological conditions. Going up and down one side of the Kilimanjaro Mountains I recorded the following results: two observations at 3000 feet, very large lesions; at 3600 and 4200 also large; at 4200 and two at 4500, medium large; at 5000, medium size; at 5,500 rather small; and at 6400, very small. Actual measurements of "very large" lesions were 20 to 28 mm. in diameter, "medium" were 17 to 12 mm., and "very small" were 4 to 7 mm. That was in a rather narrow band up and down the mountain. I have also observed "medium" and "small" size spots on leaves of trees growing at 4000 feet in other places. But this was suggestive to me of effects related to environment.

An unexplained lack of rapid spread of Hemileia on coffee was about the same as what I had seen in the Belgian Congo. In two one-year-old nurseries near Moshi, Tanganyika, I observed plants completely free from attack only 20 and 30 meters, respectively, distant from badly diseased old plantations. Seed beds were observed in which the rust could be found on a few cotyledons. These were rare cases. On the whole it had not swept over the beds as I would expect a rust should do, and I know young seedlings are highly susceptible from seeing badly

diseased young volunteer plants under seriously rusted trees. It appeared to me that this rust simply did not move about so readily as might be logically expected, considering that it is a typical wind-borne disease. This, incidentally, is an example of how "logic," without study, may lead one astray. I am beginning to wonder if this rust is not in considerable part spread by workmen, insects, raindrops, and other such vectors. In another instance, I found again as I did in the Congo, cuttings in a cutting nursery, in which only certain clones were diseased. The oldest leaves of these clones had ancient spots on them. Nearby clones were observed without any rust, although the first signs of spread from the badly diseased clones would be seen in certain other adjacent clones as well.

It is possible, I think, that this slower spread of Hemileia might be used to advantage in developing control measures. The only method used to control the disease in the Kilimanjaro-Moshi area is by spraying with a copper fungicide. This is applied by both European and African farmers, and is usually one percent Bordeaux Mixture or one percent Perenox, at 160 gallons per acre. It is put on twice a year, the exact time determined "by eye." Once, just before the long Rains start, and the second time when the major part of the growth forced by the rains has hardened, and the dry season has just about started. The cost is estimated at about 44 shillings per acre (7 shillings = $1.00) per application. Some growers rely on only the first spray. If it is a sufficient amount to control the disease, it indicates that the trouble is relatively mild, due usually to elevation of the affected fields.

Spraying is, however, an expensive operation and is not after all a permanent cure. With the increasing difficulties in securing proper labor that the farmers are experiencing, and added costs of transport of equipment and chemicals, it becomes more and more difficult. Moreover, copper has some toxic effects on coffee, and with accumulative effects from years of spraying there may be still greater injuries, although this remains to be seen in the future. One of the things in which Cowgill and I have been most interested, and which we have continued to watch for, has been the possibilities of strains of coffee resistant to the rust. We know there are gratifying differences between species. In Tanganyika we saw such differences in selections in Arabica coffee. In one case progenies KP228 and F321 were observed with little Hemileia and only 20 percent defoliation from the trouble. Next to these was AC53 with an apparent 90 to 95 percent defoliation, and most of the remaining leaves spotted. Moreover, resistance was not correlated with shy bearing as these Arabicas were all known to be excellent producers. In another case selections KP23, H1, N48, KP154, and KP263 all appeared highly tolerant, with nearby AC98 and AC53 showing serious debilitation because of rust. There seems no doubt in Cowgill's mind, nor is there in mine, that breeding of coffee for resistance to rust is bound to give these coffee technicians what they want. They have not, as yet, been able to expend all the force available on this phase of coffee development, because, even in Tanganyika, there are other serious coffee troubles.

Other Coffee Diseases and Insect Pests

In the Bukoba region, both Arabica and Robusta coffees are affected by a serious leaf distortion called "roll." As the name implies, leaves are tightly rolled, and they give an impression of thick green strings on a branch. A most curious aspect. The cause is unknown, and it has as yet not been fully investigated.

There are sporadic attacks of Cercospora leaf spot, in both the Bukoba region and in the Lyamungu-Kilimanjaro area. In only exceptional cases was coffee found much diseased by this trouble, except in the nurseries where it sometimes becomes quite a serious cause of defoliation. Occasionally Armillaria is found attacking shade trees and coffee trees, causing the curious stem-splitting characteristic of the trouble. Some of these trees were observed. The trouble is controlled by eradication, and by trenching the affected areas. Replanting in diseased soil is practiced after a time, with both good and disappointing results.

With respect to insects, the most troublesome is Antestia. This is so severe that at the moment it is considered the most important single trouble of coffee. This bug not only injures the flower buds, and sucks the plant juices, but it carries with it spores of the fungus Nematospora. These it introduces into the coffee fruits where it causes the so-called "zebra" seeds, and of course damage to the endosperm of the seeds that completely destroys its quality. The white stem borer also occurs, as does thrips, lygus, and occasional damage from berry moth, leaf mines, and the fruit borer. The large stem borer, Anthores leuconotus, is the most troublesome borer, and is controlled by introducing an insecticide into its tunnels at the base of the tree.

Methods of Growing Coffee

The handling of Robusta coffee trees in the Bukoba region has aspects about it of unique interest. In the first place tribal and territorial law prohibit destruction of any growing coffee trees unless they have been assessed as diseased. This goes back to pre-history, and is a guard against spite work. The assessing is now done by an agricultural official. Trees obtain great ages in that region, and we were taken to see some that had been under cultivation, it was estimated, for over a hundred and fifty years. They were large trees and it was claimed that some produced 15 to 18 pounds of clean coffee a year. Such trees were growing under banana shade, by methods that had been developed by folk usage. They were pruned according to what they called the "candelabra" method. Multiple stems were encouraged, and these were treated so that their bases grew for considerable distances almost horizontally, and partly buried in soil and debris. Such a tree spread in all directions and one, that was no exception, was seen that covered an area of soil 35 feet in diameter. Such trees were of course considered as individuals, and in that region the number of these large trees is the measure of a grower rather than the area of land.

In this same region Arabica coffee is handled in the same fashion as the Robusta, but with less success, largely, I believe, because of the Hemileia rust. This weakens the trees, that are then attacked by the stem borers. All coffee is grown closely connected with bananas, of both the cooking and fruit types of which there are a large number, and which are the staple food and beer-making products of the Africans. Mulching is thoroughly done in the combined coffee and banana patches, and in some instances the natives inter-plant parts with beans or some other low-growing vegetable at given seasons.

On visiting the Kilimanjaro region, coffee was found to be grown in a much more highly refined manner. All were Arabica plantations, and whether African or European operated, were clean cultivated. Trees were at about the same spacing common in many other countries. They were mostly pruned to a one stem system,

topped at a little over waist height, and secondary stems forced out at right angles. Shading was practiced, and the appearance of these shambas was very reminiscent of the fincas in Colombia. There is, however, considerable evidence of farmers following some of the more recent findings of the horticulturists who have obtained better results from multiple stem trees. Old single stem trees are converted to multiple stems by an intricate system of removing laterals on the east (more shaded) side, encouraging basal sprouts, and keeping these growing by "breather branches" above, until they can start full bearing.

The Agricultural and Coffee Officers, who are picked men and speak the native dialects fluently, know the African philosophy, in addition to being well-versed in coffee culture, are given much power with respect to how shambas are treated. They are continually making the rounds in their districts, talking to African and European growers, answering questions on practices, and advising on changes to be made. One of these Officers has the right, apparently, to condemn a poor shamba and see to it that it is destroyed. He can use every method available to force any grower to keep his shamba in a thrifty and productive condition. This is something I have seen in several parts of Africa. It seems to be a characteristic of several Colonial systems. It is nothing short of amazing to someone accustomed to the more unregulated ways of the Latin Americans, where we allow a man's finca to go gracefully back to bush, and the man into poverty, without interference; or, on the other hand, we do all in our power to assist the man to keep his land as a source of wealth, according to his own inclinations.

In Tanganyika, although coffee production is a regulated affair, it is based on research and demonstration studies. One of the most obvious things that has been done is developing and testing of improved strains of coffee. One of our important purposes in the visit to this Protectorate was to know more about these tree selections and the other work along these lines.

Coffee Plant Materials Secured or Promised, and Herbarium Specimens Collected

It was soon evident on studying the coffee in the Bukoba region that Robustas and Arabicas there did not differ materially from what we already have in the American Tropics. However, when we arrived in Lyamungu, we encountered something quite different. Here, the old collections made by the Germans and grown in Amani had been brought and established in a "museum" planting in this more accessible place. A great many other coffees had been added through the interested industry of British scientists and we went through this rich representation of the genus Coffea. Unfortunately for the comparative appearance of differences in susceptibility to the rust, the plants were well cared for and properly sprayed. After a considerable study, Cowgill asked if we could secure seeds and some living plants of some of the outstanding items. He was given a warm reception regarding the request, and the list he gave to them is as follows: "N" selections 3a, 197, 100, 50, 205, 48; R-[illegible]; L-1; H-66, H-1; "KP" numbers 423, 263, 228, 532; K-321; AC-53, AC-98; P-313; I-60; F-502, F-840; S-16; Congensis, Eugenioides, Ligustroides, Mauritiana, Swynnertoni, Salvatrix, Travancorensis (Madagascar), Lacnostoma Idiasiana, and Arabicas Amphillo, Geisha, Mibirizi, Sudan Barbuk, and Sudan Rume. Five of these were selected because of extremely high resistance to Hemileia, and three for extreme susceptibility. This list was readily promised, and it is expected that the men in Lyamungu will probably send a few more than those listed that they consider may be of the most interest to us.

While making the disease observations I have inevitably secured and prepared selected material for herbarium specimens. Such from Tanganyika consisted of seven accessions: two of which dealt with Hemileia vastatrix, an example on Arabica coffee each of mite damage, Cercospora leaf spot, Pestalozzia, "weak spot," and a possible rust on Commelina bengalensis (not examined by microscope).

List of Most Important People Met

1. Mr. M. Jarvis, Agricultural Officer, Bukoba
2. Mr. J. Reakes-Williams, Junior Agricultural Officer, Bukoba
3. Mr. J. Waters, Horticultural Officer, Moshi Native Coffee Board, Moshi
4. Mr. M. Cooper, Agricultural Officer, Moshi
5. Mr. D. G. Jones, Sub-Director, Coffee Research Station, Lyamungu, Moshi
6. Dr. L. M. Fernie, Horticulturist, " " " " "
7. Mr. R. G. Tapley, Entomologist, " " " " "
8. Mr. A. L. B. Bennett, Executive Officer of Moshi Native Coffee Board, and Adviser to the Kilimanjaro Native Cooperative Union (KNCU), Moshi
9. Mr. Jacob George, Building Administrator, KNCU, Moshi
10. Mr. Aloyse Mlay, Librarian, KNCU, Moshi
11. Mr. Henry Rumishu, Secretary, KNCU, Moshi
12. Mr. W. R. Fordes, Liquorer, Moshi Native Coffee Board, Moshi
13. Mr. A. W. S. Malcolm, Commissioner of Cooperative Societies, Moshi
14. Mr. U. H. Munk, Manager, Tanganyika Coffee Curing Company, Moshi
15. Mr. J. I. Thomas, Statistician, Coffee Research Station, Lyamungu

NOTE: A short special report will be prepared regarding some of the more sociological aspects of the indigenous people of Africa. In this will be discussed briefly the advances made by the Chagga tribe of Tanganyika, through the intelligent assistance of men listed above.

/s/ Frederick L. Wellman

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

[redacted]

SEVENTH REPORT

Delhi, India
October 10, 1952

To: Claud L. Horn, Head, Research Development Division, OFAR, United States Department of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

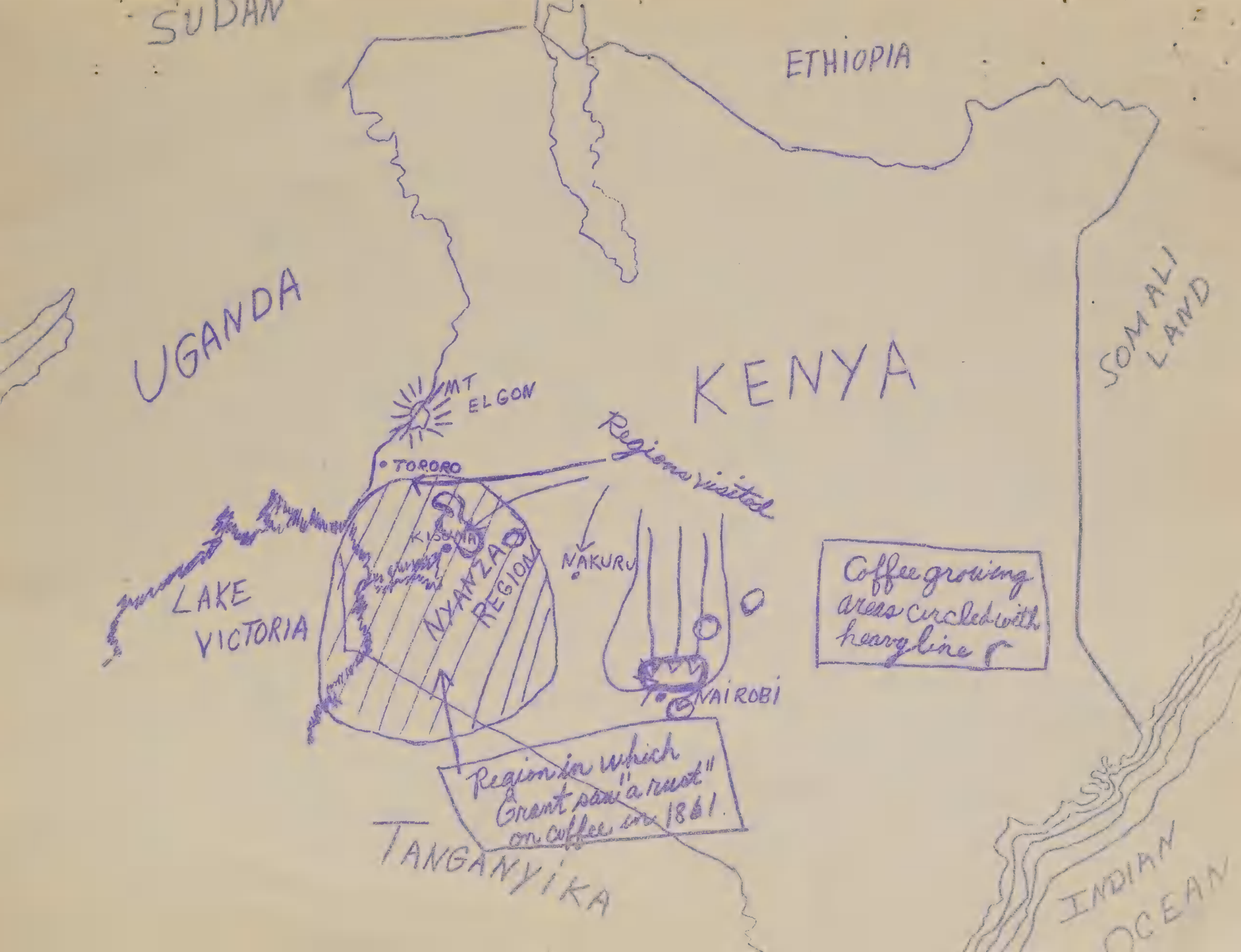
Subject: Continuation of the World Coffee Trip - Report on Kenya, Africa, September 19 to 21, and September 27 to October 3, 1952.

The third country in which we worked in British East Africa, and the seventh and last in Africa, was Kenya. It developed that we spent in it, in many ways, our most fruitful period of study up to this time on this trip. This is not surprising when it is realized that here is where some of the most intensive studies on tropical agriculture have been in progress for a long time. One reason for this is that there has been a concentration of European Farmers in this colony for quite a long period. They are, apparently, of the sort that have asked for, and required, reasonable answers to questions about agriculture that had never been posed before. In addition, the British have evidently felt quite seriously the responsibility for the welfare of the Africans in Kenya, and have worked and are continuing to work on problems brought to them by both Whites and Blacks. This has given a stimulus to science there, and has fostered the efforts of first grade scientists attracted to this vigorous land from the best training in England.

In flying across Kenya one realizes immediately that it is a big Colony. Statistics say that there are 225,000 square miles in it; whether by automobile or by plane, it is impressive to see it rolled out on all sides before you. There are some extreme heights in it, for example, the perpetually snow-capped Mt. Kenya (Kinyili of the Africans) that is over 17,000 feet high. There are also other abrupt uplifts along the edges of the valley of the Great Rift, that extends through it. Soda and fresh water lakes, with massive hills reflected in their varicolored waters, add to the charm of the landscape.

I was told that over half of the country is arid, and unused except by hardy African herdsmen, and by scattered tribes that live by hunting. Their homes can be seen, here and there, a group of huts near some rare water source, surrounded by a "boma", which is a stockade of posts and thorns, to guard against dangerous night animals. In the southwest, however, there is a well-tamed plateau ranging from four to ten thousand feet above sea level. Here it is that those who cultivate the land are situated. They are of both African and European races.

Some decades ago the White colonists secured the lands on which they are now located by various legalistic measures, under recognized laws and regulations. A circumscribed area became their property. Since then, the Colonial Government,


SUDAN
ETHIOPIA
UGANDA
KENYA
SOMALI LAND
MT ELGON
TORORO
Regions visited
KISUMU
NYANZA REGION
NAKURU
NAIROBI
LAKE VICTORIA
Coffee growing areas circled with heavy line
Region in which "Grant saw a rust on coffee in 1861.
TANGANYIKA
INDIAN OCEAN

not wishing to enhance the development of animosity between the races, put a limit to the outline of what could be included under White ownership. These limitations have been carefully observed. When one travels through this "White Man's Land" or "European Highlands" one cannot help but realize the good that can be made of Africa.

Around these "white man's" areas, and close by, are African reserves on the same soils and at the same altitudes. In these reserves agriculture had advanced greatly, in a comparatively short time. There is, as one might inevitably expect, a certain amount of jealousy on the part of certain sectors of the African population, who hold that Europeans took the best and left the poorest for them. This is not true. Intelligent observers, of both races, hold that the African has made vast gains from the presence of Whites. Efforts are being made by sympathetic Colonial officers to make the African agriculturists as efficient as any other. How long this will take remains to be seen, some say fifty years, some say three hundred. Great progress has been made since the beginning of this century.

Whatever else may be thought about progress in Kenya, the values of scientific research are evident to one who looks. Both applied and basic scientific work have been done, and the Colony recognizes and realizes the values these have brought to all Africa.

From what I could see, the Colony of Kenya is the center of British East Africa. You can learn in Kenya more about the generalities regarding British East Africa than in any other Colony. Enquiries disclosed that Colonists considered that, in their Equatorial Belt, it was not healthy on the whole for Europeans to live at an altitude of four thousand feet or less. Between five to nine thousand is well regarded for living. Above that is felt to be too rigorous, and at about 15,000 feet mountains are clothed in perpetual snows. There are, generally speaking, two rainy seasons. The "Long Rains" commonly last for about three months and come during March to June inclusive. The "Short Rains" that only last four to six weeks are somewhat capricious in arrival, coming during the period of September through December. The lower agricultural regions have usually between 35 to 45 inches of annual rainfall, and in the higher regions it may go to 60 or 70 inches. A most important demarcation between good and poor agricultural areas is the Great Rift Valley. In coffee, for example, the areas "West of Rift" are much poorer for the crop than those "East". It is not due to differences in elevations, latitudes, or soils, and not to the total rainfall, but is due to the distribution of the rains. The Rift, its great ditch being often 1500 feet deep, 40 to 60 miles wide and thousands of miles long, vitally disturbs the monsoon winds and rains, making them irregular in effect "West of Rift". It is no wonder, then, that the largest populations are located East of the Rift, and here is where one finds Nairobi. It is around this city that several scientific institutions have developed.

Institutions Visited and Importance of Coffee

There are more institutions dealing with science and agriculture in Kenya than we had time to visit. Those selected seemed to be of special significance for us, and could be fairly readily seen in the comparatively short time at our disposal. These institutions are as follows: 1. Kenya Department of Agriculture, P. O. Box 338, Nairobi. 2. East Africa High Commission, Nairobi.

3. Coffee Research Station, Jacaranda Estate, Ruiru. This included substations at Ammer, Kiambu, Mukuya, and Kentmere. 4. East African Agricultural Forestry Research Organization (EAAFRO), Kikuyu, P. O. Box 601, Nairobi. 5. Rukera Coffee Demonstration Farm. 6. Pest Control (E. A.) Ltd., P.O. Ruiru. 7. Coffee Board of Kenya Planter's Cooperative Union, Nairobi. 8. Leslie and Anderson Co. (Affiliate Edm. Schluter and Co. Ltd., London), Nairobi. 9. East African Herbarium, P. O. Box 5166, (administered under EAAFRO) Nairobi. 10. Scott Agricultural Laboratories, Nairobi. 11. Offices and laboratories of liquorers and classifiers of Kenya Coffee Board. 12. Sale and auction organization of the Kenya Coffee Board.

In all of these institutions visited, dealing was with coffee as an important factor. Some, as their names indicate, were purely coffee institutions. In the case of the East African Agriculture and Forestry Research Organization, coffee problems were of minor consequence in their organization. Their work was largely on basic problems of Tropical Agriculture. Everywhere, we were impressed with the importance Kenya gives to coffee in its economy, and its value there is growing. I was told that of late new acreages are increasing at the sensible rate of about one percent per year, that they did not want a boom development in the culture. They wish research to more than keep pace with increased planting. The value of research is realized in that country for without it they would not be the world's chief producer of pyrethrum. The farmers also grow a large amount of sisal fiber, and here again special research stations, as in the case of pyrethrum, have worked upon and solved, the problems of the crop. One of the interesting developments we heard about in sisal was the construction, now in progress, of a plant to convert decortication waste into cortisone precursor. They believe this may lead to almost as great returns to some growers, as are now being realized for the fiber itself. Kenya also exports maize and hides as well as coffee.

Coffee is freely said in Kenya to be their most important crop for securing money forworld exchange. The total area planted to that crop in the colony at the end of the 1951 season was 61,790 acres. About 2000 of these acres are being grown by upwards of some 2300 African planters. European growers average 300 to 400 acres each in their shambas. The total export of coffee from Kenya in 1951 was 167,986 bags (60 kilo), and the estimate for 1952 is 275,000. Whenever anyone talks about coffee in Kenya, he is listened to with much interest, and this has long been true.

Hemileia Coffee Rust Disease Situation

An interesting feature of the coffee production has been its many ups and downs. Some years yields have been very low, and in many cases it is known to be a reflection of relative severity of the Leaf Rust Disease (Hemileia vastatrix). This malady has led some growers to have a fairly pessimistic view of the future of coffee shambas in Kenya. Last year it was said to be bad, and much loss was felt because of the trouble. However, good growers who were successful in the timing and application of their sprays, according to coffee specialists' recommendations, reaped a good harvest. A large proportion of coffee planters spray to control the rust.

I saw many instances in Kenya where through some accident spray had not been

properly applied to coffee, and the trees showed devastating effects from defoliation. Effects of elevation, probably a temperature relation, were observed. At the low coffee Substation, Mukuyu (1372 meters or 4500 ft.), the rust was most severe. In this area, even with spraying there was considerable rust injury. At the high Substation, Kentmere (1952 meters or 6400 ft.), the rust was readily found but defoliation was relatively of minor consideration. At the station, Jacaranda, at an intervening elevation (1646 meters or 5400 ft.), rust damage was notable even after spraying, but the leaf fall was not sufficiently great to make much apparent difference in yield.

On the whole conditions must be admirable in Kenya for retaining sources of infection, and development of severe epidemics of the coffee Hemileia. It is of first interest that "a rust" on coffee was first observed by the explorer Colonel Grant in 1861, when he was on his exploratory travels with Speke from 1860 to 1865. This rust on coffee was seen in the Victoria-Nyanza region of Kenya. It is not known whether Grant collected specimens of this rust. In any case, it was not until many years later that it was given a scientific name. But I feel sure that Grant saw Hemileia vastatrix. "A rust" on coffee would be unmistakable, and would be the one just suggested and so well known in British East Africa in modern times.

There is somewhat of a collection of preserved specimens of diseased plant material from East Africa, in the Nairobi East Africa Herbarium. I examined the section of material dealing with the Hemileia rusts and found an interesting store of them. The list is as follows: Hemileia of several species on Dioscorea, Psychatria, Alafia, Clerodendron, Strophanthus sp., Jasminum, and on Coffea. Of incidental interest is the fact that three of these, Hemileia hansfordii, H. sp. on Alafia clusioides, and H. sp. on a Jasminum, all had a superficial resemblance, under a hand lense, to Hemileia coffeicola. These observations are all by way of indicating that regions of British East Africa apparently fall well within the natural habitat of the Hemileia rusts, and that Hemileia vastatrix can well have first occurred, in Kenya, on indigenous coffees.

As was already mentioned Hemileia is worse in its attack some years than others. For example, I was told by several people that 1947, in Kenya, was a bad rust year, followed by better conditions when losses were much less. Then last year (1951) was another "bad year." The worst years are said to always follow an unusually long extension of the normal period included in the Long Rains, followed by a time in which the atmosphere is especially heavy with moisture; also when Short Rains are extended. The "better years" are those in which conditions are relatively dry, with less misty atmosphere. But whatever happens, be there long periods of drought when the coffee trees almost seem to succumb to unhappy conditions, or be the farmers unusually thorough in their spraying operations, the rust is always present ready to reinfect whenever good conditions arise for it.

It appears that spraying for Hemileia has been developed to its greatest perfection in the whole of Africa, in Kenya. A one percent standard Bordeaux Mixture (or proprietory copper spray compounds like Perenox, Blitox, or Cuprokilt) is used. A common application is 150 gallons of the spray per acre at 400 pounds pressure. Timing of applications is of most critical importance. There are two so-called "anti-Hemileia" sprays per year. One is put on some time during the latter part of the dry season, usually in October or November. The

second is put on after the Long Rains have "died down" and the coffee trees are just finishing their most vigorous "flush growth." This may be in May, June, or July. The attempt is made to time this second spray so that the majority of the foliage produced by the trees during the rains will be at least partially protected until the next Long Rains come. The Short Rains are more or less disregarded in this spray program. Spraying is done by the owner, or by one of two well organized companies that sell their services for 50 shillings (Sh 7/ = $1.00)per acre, per application.

As will be seen from the above, spraying with copper compounds is the accepted control for coffee rust in Kenya. Without it Kenya could not produce coffee as a major money crop. Spraying is, however, never a fully satisfactory method of plant disease control. At best, it is expensive, unpleasant to carry out, and not a permanent cure. The beginnings have been made to secure highly resistant coffees for Kenya, although so far this effort has been secondary to spray studies. Work has been in progress for over 13 years in coffee selection for higher production, adaptability to local conditions, and with attention given to Hemileia resistance. Before we had even seen any fields I was told that the most important, promising Arabica coffee selected had been one called "K-7". It is said to be, year after year, a resonably good but not excessively heavy bearer. It is well suited to Kenya coffee shamba practices. It is also very tolerant to Hemileia attack. In some instances, especially when grafted on to susceptible stocks, it appeared to "breakdown somewhat" in Rust resistance, but it was still highly resistant. It was likewise stated later, after we had seen the material, that drought resistant selections, SL-7, SL-17, and SL-28 were all highly tolerant to Rust.

When we went to the fields where collections of coffee strains were growing, side by side, under unsprayed conditions, I could observe consistent differences in resistance. These observations I am presenting in the form of tables, as follows:

Table of differences seen in severity of Rust attack on coffee selections grown in three unsprayed field plantings in Kenya (Planting One, 10 years old; Planting Two, 6 years old; and Planting Three, much older than either one or two) - October, 1952.

PLANTING ONE

Strain	Spots Per Leaf /a	Defoliation /b	Strain	Spots Per Leaf /a	Defoliation /b
Commercial	4-5	Moderate to serious	Kit.-61	3-4	Moderate
SL-10 /c	8-18	Very severe	Kit.-145	4-5	"
Commercial	5-8	Moderate to serious	Commercial	4-5	"
SL-33	1-4	Little	M-65	4-5	"
SL-28	1-4	"	Kit.-85	4-6	Moderate +
Commercial	4-5	Moderate	Commercial	4-5	Moderate
Kit.-251	4-5	"	Kit.-37	3-4	"
M-83	4-5	"	Commercial	4-5	"
Commercial	3-4	"	M-6	4-5	"

PLANTING TWO

Strain	Rust Attack /b	Strain	Rust Attack /b
Commercial	Medium	SL-28	Little
SL-3 /c	Very severe	Commercial	Medium
Commercial	Serious	SL-30 /c	Extremely severe
SL-9	Mild	Commercial	Serious
Commercial	Medium	SL-34	Mild
SL-14	Moderate	Commercial	Medium
Commercial	Medium	KS	"
SL-17	Mild	Commercial	"
Commercial	Medium	J-2D	"
		Commercial	"

PLANTING THREE

Strain	Rust Attack /b	Strain	Rust Attack /b
Commercial	Medium	SL-28	Little
SB-3 /c	Very severe	Commercial	Medium
Commercial	Serious	SL-30 /c	Extremely severe
SL-9	Mild	Commercial	Serious
Commercial	Medium	Commercial	Medium
SL-14	Moderate	SL-34	Mild
Commercial	Medium	KS	Medium
SL-17	Mild	Commercial	"
Commercial	Medium	J-2D	"
		Commercial	"

Footnotes: /a Spots on lower mature leaves. /b Estimates made, increasing order of severity as follows: "Little", roughly 10% defoliation; "Medium", 20%; "Moderate", 25%; "Serious", 30%; and "Severe", 35%. /c Selection from Harar variety. /d K-7 was seen in more than this one place, and no rust spots could be found on the plants.

It should be very clearly understood, that in presenting these observations in the attached tabular form, that I do not imply they are altogether definitive data. These are from one observation, by one person. With much to cover regarding the coffee in Kenya, I did not attempt the extreme exactness one attains on deliberate study. The Hemileia disease classifications are my own, and not based on a more exhaustive study that would need to be made to produce adequate and repeatable data. However, there are some suggestive points. 1.- The variety Harar, from Ethiopia, is highly susceptible, as are selections from it. 2. - Selection K-7 is highly resistant, as are a few other special selections. 3. - The so-called Gimmas, Dilles, Dalles, and Sudans, are, if not immune, at least highly resistant. 4. - The common Arabicas such as those listed as Bourbon, Guatemala, Commercial, and Blue Mountain are readily attacked by the Rust. 5. - Certain special selections isolated as adapted to Kenya conditions and drought resistance, showed more resistance to Hemileia than did the commercial field-run Arabica. 6. There seems little doubt that resistance is genetic.

Such observations as these were of special interest to a technician such as Cowgill, for here we had for the first time fairly conclusive evidence before us, that control of the disease could be made to yield through efforts of the plant breeder.

That resistance breeding work has not been carried on to its ultimate conclusion in Kenya is understandable. It is a long and laborious process for one thing. It is, in fact, in slow progress at present and the basic plant materials are on hand. However, spraying has solved the crisis, halting excess Rust destruction. The Colonial research work is necessarily handled with a moderate amount of materials and a limited number of individuals. These materials and workers have also had to solve spectacular invasions of other diseases and pests.

Other Diseases and the Insects of Coffee

The Coffee disease being given most intensive study in Kenya at present is the Coffee Berry Disease (Colletatrichum coffeanum var. virulans). This is also found as serious in Uganda, Tanganyika, and the Kivu area of the Belgian Congo. The causal organism is apparently a rather specialized form, and not a generalized parasite like some other Colletatrichums. It has been studied by several pathologists, but more especially by Dr. R. W. Rayner (who, unfortunately for me was on home leave while I was in Kenya), Plant Pathologist and Physiologist, and his assistant, Miss Joan Gore, who is carrying on work on the trouble in his absence. It has been studied in the laboratory, and, by controlled inoculations and reisolations, in the field. Culturally and microscopically, this strain is readily differentiated from common C. coffeanum. Moreover, it does not seem to attack leaves and stems, it produces a distinctive spot on fruits, and is not recovered from branches attacked by typical Colletatrichum dieback disease. There are some questions regarding its residence between its appearances as a fruit trouble, and methods of distribution, ecology, and control measures are under investigation. It is significant that Rayner and Gore are combining both host physiology and the more common pathology studies to resolve this complex disease.

In addition to this work on the Coffee Berry Disease, more effort is being given to a fuller understanding of why the "tonic" sprays for coffee have the good effects claimed for them. "Tonic" applications are 1% Bordeaux or $\frac{1}{2}$ to $2\frac{1}{2}$ % Burgundy or 4% Perenox, Blitox, or Cuprokilt, and variations of these. They are put on

once a year, at most any dry time, at the rate of 100 gallons to the acre sprayed on at about 100 pounds pressure. After the so-called "tonic" effects were well demonstrated, several types of studies were employed to find out what was taking place. The theory of a copper deficiency trouble, not readily expressed by plant symptoms such as leaf discolorations, was explored. A number of other theories based on physiological possibilities were also examined. One by one these proved negative. It appears that the "tonic" effects are due to a sufficient reduction in a number of usually harmless acting fungi, that, when undisturbed effect incipient leaf-petiole infections. When tissues are exposed to excess drought they are rendered more susceptible to miscellaneous fungus invasions. The result is a large amount of leaf fall. This has been given much detailed study, and further investigations will soon be continued when Rayner returns to Kenya.

The work of the Pathologists in Kenya is, in a way, overshadowed by the work of the Entomologists. Insects are, after all, a more spectacular group of parasites; in the main, they move, and are readily seen by the naked eye. But that is not all: Insect pests are a major, critical problem on coffee in this country. Entomologists are making studies with the most approved methods, and are devising techniques more highly adaptable to the Tropics. The pests that are of the main interest on Kenya coffee are as follows: Antestia and Copsid, control studies. Coffee thrips, Diarthrothrips coffeae, are watched by Kenya-devised sampling methods and farmers are advised immediately when and how to apply control measures. The Mealybug, Pseudococcus kenyae and its attendant ant, Pheidole punctulata, are being studied for life history. This is probably the worst coffee pest in the country. Control has involved search in many countries for parasites, and breeding them in Kenya for release in the field. The almost microscopic-sized "wasp" Anagyrus kivuensis is at present being used with much success. The White Borer, Anthores leuconatus, and the Yellow Headed Borer, Dirphya princeps, are also being studied for life history to determine what time it will be best to protect coffee tree bases with insecticidal applications. The Tingidae are also being studied. "Zebra Seed" is a disease due to injection by Antestia bugs of spores of the fungus Nematospora (lygus?) inside the parchment and silver skin coverings of coffee seeds. It is of great importance in limited areas, and is handled as a purely entomological problem.

At every turn the Entomologists, Pathologists, Physiologists, Horticulturists, Agronomists, and officers dealing with extension responsibilities, all work in close cooperation. This is to insure at all times a true practical bent to the research work, and the greatest chance for applying indicated changes in methods to the growing of coffee.

Methods of Growing Coffee

It is believed in Kenya that control of weeds, between coffee trees in the shamba, is intimately related to insect control. For example, anything that disturbs ants also reduces aphid, scale, and mealy bug infestation; by slowing spread through removing the ants that act as attendants, and protectors against the parasites whether they are insects or fungi. Some of the weeds are also cover and hosts for immature stages of coffee insects.

On the whole, however, weeds are kept down to a minimum for their own sake. In a large part of the growing districts, the rains are not so well distributed that there is sufficient for both weeds and coffee the whole year. Machine and hand cultivation is regularly practiced. Some interest has been shown in chemical

means of weed control. Thus far it is not economically profitable. Farmers like rainy season growth of dicotyledons to slash down and turn under. The worst trouble is "coach grass", Digitaria sp. The chemical compound TCA will successfully eliminate this grass, but in proper amounts it also eli inates the coffee! Weeds are, in addition to cultivation, kept down by mulching.

For some years work has been in progress on basic problems of coffee mulch. Elephant grass is often used but so are other materials. This grass is grown and fertilized as a regular crop in a field by itself. About half of the acreage given to coffee is used for mulch grass. A special hairless Elephant grass has been bred for this special purpose. Years of study have shown that chemical fertilizers, applied directly to the soil, in the shambas, give practically no returns in extra coffee harvest. However, results are very worthwhile when applied through the mulch.

The grass is cut and cured before it is hauled to the coffee field. It is usually put between alternate rows in a 6-inch deep band, that settles to 4 inches which is considered minimal for good results. The bands cover row middles to within about 18 inches of tree bases. It is put on after the Long Rains, one year on one side of the row and the next year on the other. Mulching not only adds fertility and improves the soil's physical condition; it also conserves moisture, lowers the soil temperature, stops soil cracking and almost completely prevents erosion. Washing away is further reduced by planting coffee roughly on contours. By Kenya laws no land can be planted to coffee that has a slope of 20 percent or greater. Usually the gentlest slopes are employed.

The Kenya coffee shambas that we saw at the moderate and low altitudes were very handsome in appearance. They were weed free and unshaded, although shade was used in the higher parts. Coffee trees were, moreover, largely pruned to a single stem. They were topped at about head height, and lateral stems kept under control. The trees stood without touching each other in the neatest of rows, and made further attractive by the alternate striping of sunbleached, light yellow mulching, in contrast to the green of the foliage of the trees and to the other stripe of red soil in every other row of the plantation.

The single stem system of pruning is expensive of an ever decreasing labor supply, and it is gradually being replaced by multiple stems. Conversion to this takes a number of years, but horticultural research has proved both its feasibility and that in actuality production on multiple stems is much greater than that on single. In most of the very young plantations coffee is being trained to multiple stems and after a few years practically all coffee will be grown in this manner. Continuous effort on many horticultural and agronomic problems has solved numerous difficulties. The next step, multiplication and use of improved varieties, has been somewhat delayed but it appears nearly ready of realization.

Coffee Seeds Promised and Herbarium Specimens Secured

One of the things upon which Cowgill and I had pinned the greatest hopes was the securing of a wide range of new and different coffee materials in Kenya. This was amply realized, and in the museum plantings we saw things of utmost interest. For one thing, plants of Coffea congensis (so-called), sent to and now growing in Latin America, have been of considerable disturbance to several botanists and coffee men in the Americas. Cowgill has been especially anxious because he believed them to be somewhat variant Canephora collections unfortunately labelled. He had examined in the Congo plantings of "Congensis, River or Moist

Land Type" and "Congensis, Dry Land Type". The latter seemed a Canephora and like "Congensis" of the Western Hemisphere importations. The British labelled as "Congensis" the so-called "River Type" seen in the Congo. While making these studies, Dr. Pierre G. Sylvain was with us in Uganda, Tanganyika, and Kenya. Between Cowgill and Sylvain, and with the help of British scientists and reference to Chevalier's monagraph, the Congensis species problem was considerably clarified, at least for America.

When a visit was paid to the botanist, P. J. Greenway at the East African Herbarium, the congensis problem was further discussed. In addition, this scientist has collected many wild growing coffees and it is his much considered opinion that no indigenous congensis, Canephora, dewevsei-liberica, or Arabica coffees have come primarily from British East Africa. If they were wild, any of these speices, they were so as escapes. There is in the region, however, an indigenous, widely variable group that Greenway puts all under the species eugenioides. The so,called Kivaensis also comes to this group. An important specimen that was seen by Cowgill in the herbarium was Coffea zanguebariae, of course from Zanzibar. It is one of the most different types he has found in his herbarium searches. The tree is tall, deciduous, drought resistant, grows at sea level, and is said to be a popular source of the coffee beverage for the natives of Zanzibar. It is hoped that maybe through Sylvain or some other worker, seeds of this species will be obtained for study in Latin America.

About the last thing that happened to us in Kenya was a request that we prepare a list of what we might want of seeds of coffee. We had already discussed the materials seen and it was not difficult to decide what we would like. It was especially gratifying to prepare this list since it was an offer from the Kenya workers, and not upon our urgency. The list given to them is as follows:

Arabica selections -- SL-9, SL-14, SL-17, SL-28, SL-30, SL-34, SL-10, K-7, Kents F5 and Walkers I_2 Selection of K-7, then, Harar, Gimma Galla Sidama, Gimma Mbuni, Dilla and Alghe, Dilla, Dalle mixed, Dalle, (tree sel., Barbuk Sudan, Rume Sudan, Amphillo, Geisha, "Series L", "Vertical Branching", "Tight Growth", Dolichos sp., and the hairless Elephant grass (napier) used in the mulching work. The men in charge expected to send in addition to those we specifically listed, a number of other coffees that they considered might be of interest. We were given every assurance that the seeds would be sent to Washington as soon as possible after they became available. No trees were in a condition to be harvested at the time we saw them.

Both Cowgill and I had made offers of seeds, plant materials, and exchange of information, to these British workers. In every possible way we wanted to make this a reciprocal exchange. Through it we hope to be in closer touch between the American Tropics, and the British Tropical African workers.

We were offered a service to test any strains of coffee that we might send, for resistance to Hemileia. This would be done through the Coffee Research Station, Jacaranda Estate, Ruiru. We were likewise invited to establish a coffee breeding center for the Americas at the East African Agriculture, Forestry and Research Organization Experiment Station at Kikuyu.

For the record it is to be noted that I secured, preserved, and have sent by mail to Washington herbarium specimens of the following material from Kenya: Hemileia vastatrix attack on Arabica coffee, 2 collections; and one each on Arabica of Cercospora leaf spot, Pestalozzia, and specimens of fruit with Coffee Berry Disease, Colletotrichum coffeanum var. virulans.

List of Most Important People Met for Conferences

(Not including USA Personnel)

1. Mr. E. M. Gore, Reception Officer, East African High Commission, Nairobi.
2. Mr. A. R. Melville, Senior Entomologist and In Charge, Coffee Research Station, Jacaranda Estate, P. O. Ruiru, Nairobi. 1974- Director of Natural Resources Mgr. Overseas Devel. + Aid London England
3. Mr. P. A. Jones, Agr. Officer, Coffee Serviceo, Ruiru.
4. Mr. D. J. McCrae, Entomologist, Coffee Research Station, Ruiru.
5. Mr. N. Mundy, Farm Manager, Jacaranda Estate, Ruiru.
6. Mr. G. R. C. Vansomeren, Entomologist (
7. Mr. O. H. Waring, Contract Manager (Pest Control (E. A.) Ltd., P. O. Ruiru
8. Mr. P. Collins, Secretary (
9. Mr. H. A. Archer, Manager, Coffee Board of Kenya Planters' Cooperative Union, Nairobi. (CBKPCU).
10. Mr. W. H. F. Robson, Sub-Manager, C.B.K.P.C.U.
11. Mr. W. J. Wheeler, Taster and Broker, of Leslie and Anderson, Nairobi (Affiliated with Edm. Schluter & Co., Ltd., London).
12. Mr. W. R. Ingram, Entomologist, Coffee Research Station, Jacaranda Estate, Ruiru.
13. Mr. C. R. Devonshire, Liquorer and Classifier, CBKPCU.
14. Sir Bernard A. Keen, Director, East African Agriculture and Forestry Research Organization (EAAFRO), P. O. Box 21, Kikuyu.
15. Dr. F. M. L. Sheffield, Virologist (plant), EAAFRO.
16. Mrs. A. K. Ryland, Plant Pathologist, EAAFRO
17. Dr. H. H. Storey, Plant Pathologist, EAAFRO
18. Dr. R. H. lePelle, Entomologist, Scott Agricultural Laboratories, Nairobi
19. Dr. R. M. Nattrass, Plant Pathologist, Scott Agricultural Laboratories, Nairobi
20. Mr. P. J. Greenway, Botanist, East African Herbarium, EAAFRO, P.O. Box 5166, Nairobi.
21. Mr. B. Verdiooren, Botanist, East African Herbarium.

/s/ Frederick L. Wellman

Frederick L. Wellman

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

(1)

[redacted] USE ONLY

REPORT NO. 5

Manila, Philippines
November 9, 1952

TO: Claud L. Horn, Head, Research Development Division, Technical Collaboration Branch

FROM: Frederick L. Wellman, Pathologist, Research Development Division

SUBJECT: Continuation of the World Coffee Mission - India Report, October 5 to 22, 1952

Coffee has an old and somewhat romantic history in India, and the business has suffered various vicissitudes through the centuries. There is a legend that a certain great Babadur Sahib, now a Saint among Muslims, made pilgrimage to Mecca sometime just before the year 1600 (A.D.). While there, being a man of parts, he became interested in coffee as a beverage. He secured seeds of the good tree and, safe in his pouch at his belly, he brought them home on his return to India, where he planted them on a hill. Thus, it is said, came coffee to India.

Babadur Sahib now lies buried in a wind gap in the mountains where his coffee was first grown and those mountains, the Babadurgiri, took his name. His tomb has to this day on its top, encased in solid masonry the two pilgrimage sandals of the old saint. Curiously enough he is venerated no only by Moslem, but also his sarcophagus is worshipped as a Hindu Shrine. There is, I suppose, no great wonder in that, because not only was he originally a Faithful of Allah and a Protector of Mecca, also the Hindu goddess Shiva makes the harvest, coffee has meant much to India, and Babadur Sahib brought it. Here was an ancient Sahib who knew a good thing when he tasted it. He was a saint alright, but one that loved life and the good things of living.

It is not said in the annals, whether the coffee seeds brought by Babadur Sahib were of Arabica or Rubusta type. However, probably the former, because the finer high quality species has been the only one grown in India for over three hundred years. It is only recently that the acrid flavored Robusta has come into commercial use. In those first years coffee was grown in small enclosures or around buildings, a few trees at a time. Such growing is still carried on to this day, and the seeds lovingly gathered for their eventual product of the fragrant, stimulating crop. It was not until about 1800 that coffee became an industry of wide concern in India, and the crop has been grown in the hills, not only of the Babadurgiri above the city of Chikmagalur, but in the wonderful hills of the Nilgris, of Coorg, of Southern India.

The first India experimental gardens for coffee, were established in 1799 near Tallicherry, which is in North Malabar. This was a project of the justly famous old East India Company. From the efforts of those pioneers, coffee growing was popularized in a small way to supply demands in India, and as well for some shipments overseas. From the Tallicherry Gardens planting spread North and South and East, into the higher cool hill station lands of Malabar, West Mysore, the Coorg, the Nilgris, and down into Travancore and Cothin.

Religion may have played an important part in India coffee growing. Some alcoholics are used but most of the followers of the deities in the Orient frown on such stimulants and on tobacco. They, instead, take respite from care and get heightened mental and physical energy from tea or coffee as a drink, or by chewing of lime buttered betel leaves and the areca palm kernel. From the beginning in India, the soothing draught of coffee was well appreciated. This was the more so because it came from a Great Pilgrim. The quality of that early Indian coffee was excellent. It spread as a special luxury to the bazaars of Hong Kong, Singapore, Cairo, Constantinople, and latterly into the shipments to England and West Europe.

Present Importance of Coffee and the Hemileia Disease Situation

Through the East India Company, India began to develop an export trade in coffee. Along with the great shipments from Ceylon, India Coffee was drunk by Ben Johnson and his ilk in the now extinct, famous old London Coffee Houses that were the sources of much poetry, philosophy, political thinking, and great conversation. The Maharajahs and District Heads in India encouraged coffee culture, and by the time of the years just before the First World War, South India coffee had got and kept a name. It was grown, after a time, only in restricted districts because of a disease that menaced plants at lower altitudes where they once flourished. But it made good export money. With vicissitudes of war and depression, and as a reflection of Brazils coffee market manipulations, coffee became a largely unprofitable growth for outside commerce. The coffee gardens languished, and many were abandoned. It became "the poor man's drink", as tea still remained the money making export.

Since that time, however, the coffee growers banded into loosely bound cooperative groups. After England had redeemed her long held promise, and India became an independent member of the Commonwealth, there was established the India Coffee Board. Their business has been to keep Indian coffee producers from bankruptcy, and to see to it that India was at least self sufficient in her own coffee requirements. In the recent last two years they have been selling a little to the outside. There is much interest in possible increase in this direction.

In 1940 about 180,000 acres of coffee were in production and by 1951 there were 229,000 acres. In the crop year 1950-1951 the growers in India produced 251,475 bags (60 kilos), and the estimate for 1952-1953 is 356,000 bags. At present most of the coffee grown is still Arabica, as may be seen by the fact that in 1950-51 of the production just mentioned only something over 11,000 bags were of pure Robusta beans. But the latter is gaining in popularity for growing in areas where Arabica shows the most delicacy because of either weather or disease conditions.

It is likely that at the moment, the new acreages of Robusta are increasing more rapidly than those in Arabica. This is not because there is any less popularity in the taste for the good Arabica flavor, but it should be repeated, it is because the rust disease, Hemileia vastatrix, continues to encroach upon even those areas where it was at one time thought it would not reach, and onto varieties at one time considered practically resistant to its attack. The wild flavored Rubusta is, undoubtedly, a much more rust tolerant coffee species; and in these days of abnormally high prices for anything that furnishes caffein to the drink, the coarser product is being gratefully received. The rust has made much difference in India.

In this regard some of the more recent history of Arabica coffee development in India may be of interest. First it must be recalled that the rust disease struck Ceylon in the early part of 1869. By the end of that same year it had reached India. Five years later it was causing much trouble in southern India as it swept northwards in the subcontinent. It became, and has continued to remain, the one most serious enemy of coffee in the region. It is called in India today "the dread leaf disease", and its advent is often branded as "the Great Catastrophe".

Old Coffee Selections

Long before the rust had attacked coffee in India, the crop had become an established one proceeding from those old original seeds credited to the Babadur Sahib introductions. The first were grown in the mountains that circle the old city of Chikmagalur, and these were spread out over hill regions of Mysore under the Rajahs. Leaf rust cript from region to region, and when it came to Chikmagalur, there were some plants found by the old growers that seemed to be fairly tolerant of the fiercest rust onslaught. These were kept aside and multiplied, and called the "Old Chiks". They were a type of hardy Arabicas, strong growing and rather upright in habit, with thick leaves and large grains; the "Borbon" type of the American Tropics. They soon replaced highly susceptible Arabica trees.

However, after a time the Old Chiks began to succumb to the rust. They may have always had a few spots, but the infections increased and in a small number of years, the trees began to lose more and more leaves until they became no longer profitable. Meanwhile, farther south in the land of Coorg, another apparently resistant variety had been found. It was called "Coorg" or "Nalknad", and was introduced into other wasting regions about 1871. It was later to follow the same history as the Old Chiks. The plants carried only a few spots to start, but as the years went on they increased in number on the trees, and after a while Coorgs were as susceptible as the Old Chiks.

Simultaneously while all this was in progress some close and intelligent observation and selection was being carried on, largely in Mysore. About the year 1844 a planter by the name of Hamilton of Chendrapore Estate found what was evidently some natural hybrids of the two coffee species arabica and liberica from plants that he had that were growing side by side. He noted the differences in vegetative characters, and also saw that some were capable of growing completely free from rust while others succumbed all around. This find of Hamilton's stirs the scientists who hear about it or see it. It is an interspecific cross between trees of widely variant appearance, resulting in a good intermediate type. Also,

it is resistant to a disease, and both of its parents are susceptible. Other growers, both India and European, secured seeds from these resistant plants. One of them, H. C. Brown of Netraconda Estate, reselected from his "Hamiltons" a type of coffee more suitable to his needs than were the original plants he had secured. From the work of Brown came the "Browns", "Netracondas", Hamiltons", "Crawfords","Macketts", and other named types all due to the original acuity of Hamilton.

While these varieties with their mixed blood are highly resistant, they are not the best from many horticultural standards. Realizing this another planter, L. P. Kent of Doddengudda Estate, was specially pleased when he found one plant that was highly tolerant in a large field of Old Chik and Coorg trees. Thus arose "Kents". This was about 1917, and he collected seeds from his pet tree, and reselected progenies to his own liking. It was an excellent type, high yielding, of Old Chik conformation, extra vigorous, and although it was attacked by Hemileia the plant was sufficiently tolerant to the rust that it produced crops where other Arabicas were failing completely.

These types of observations and selections are still in progress, mostly under the expert eyes of plant technicians. While at the Experiment Station at Balehonnur, in Mysore State, I had a chance to see 25 different coffees growing there, and to obtain an estimate at that time upon their relative susceptibility to Hemileia rust. These are listed below with designations after them with meanings as follows: R = "resistant" or apparently free; Tr = "trace"; F = with "flecks" and very small spots; M = "mildly susceptible"; S = "susceptible"; and VS = "very susceptible". "Mildly susceptible" trees were losing a few leaves because of rust but not serious amounts, "susceptible" trees had lost over half their leaves and others were falling, and "very susceptible" trees were almost completely defoliated in some cases. These varieties were seen: Liberica (M); Excelsa (Tr); Abeocuta (R?); Robusta (M); Uganda (S); Quillou (S); "Hybrid" ever flowering (VS); Canephora (M), Stenophylla (F); Arabica Margogipe (VS); Arabica Kent (S); Arabica Coorg (VS); Arabica Commercial Old Chik (VS); Arabica Baramasi (VS); Arabica "Grafted" (VS); Arabica M14 hybrid (VS); Arabica S44 (F); Arabica S26 (M); Eugenioides (R); Zanguebarensis (F); Bengalensis (Tr); Rubusta and Arabica cross (F); Liberica and Arabica cross (R); "Congensis of dry land type" (S); and "Wild Arabica from Anglo Egyptian Sudan" (M).

From what is evident in this list, and from the history just reviewed, it can be seen that coffee men of India were early aware of the promise of resistance to rust. This is the ideal towards which work is progressing. But this is a long and arduous road, although it is recognised as the only final solution. It was known that it would take years, and in the mean time the pathologists had to develop an immediate method of temporary amelioration of the trouble. If not the whole industry was doomed to the same history as that in Ceylon, Java, Malaya, and other countries where it was destroyed. The most obvious measure to which they turned was spraying.

Spraying to Control Hemileia on Coffee

All through the coffee producing years, since Hemileia first reached India, it has continued to be the one most limiting factor in growing the crop. This was, in fact, the basic need that was expressed in the establishing of a coffee research station in Balehonnur in 1926. The land was originally given by a

planter. Much careful work was immediately undertaken under the leadership of British scientists who were meanwhile training their Indian counterparts.

Their beginning work dealt with spraying as a matter of most immediate concern. From the start indications were that it held great promise. This method of control had come as suggestion through a devious course. Spraying with standard strengths of Bordeaux Mixture was first used in South India for control of a Pellicularia that causes a web blight of areca palm. It was found also to be of help in controlling Phytophthora bud rot on that same tree. Rubber was also attacked by a Phytophthora and it was used with some success there. About that time the web blight of coffee (Pellicularia), that is called "black rot" in India, was causing severe damage and Bordeaux was tried on it. The coffee trouble was cured, and it was observed that much of the time it reduced rust damage. The very first experimental spraying to control rust was tried in 1919 on a private plantation. The crop increase that year on sprayed plots as compared with unsprayed was said to be 57 percent. This was then the basis upon which those early workers built. It was next their purpose to determine the best season and the critical times of application to bring the spray program into the realm of practicability for the grower.

At about this period W. W. Mayne was brought out from England as a recent graduate in Agriculture. He was given the responsibility of studying the rise and fall of rust infections in relation to the seasons. He took up that work where the great savant Dr. Marshall Ward had left off his classic studies years before, and he followed with excellent success in his eminent predecessors footsteps. His results are known and used wherever men spray to control coffee rust. He it was who established that the most important time to apply Bordeaux was just previous to the heavy rains of the Southwest Monsoon period that occurs in India from about the middle of May to about the first of October. (That is equal to the time spoken of as the "long rains" in Africa.) Again, Bordeaux was found to be valuable when applied after this Monsoon was over. The lull in rains usually lasted at least the better part of a month and then the rains returned on the Northeast Monsoons (Africas "short rains") that occur in India in the period of November, through December. Mayne proved that spraying twice a year, at properly selected times, gave commercially satisfactory control of the rust although it was never completely eliminated. Not only times, but methods, formulae, equipment, field movements by spray teams, and similar matter were also studied. It has become a more or less rule of thumb, quite practical measure where labor is not only cheap but plentiful and reasonably skilled. Spraying is a standard practice, but the growers wait with impatience the development and perfection of the needed resistant varieties.

Attention Given to Rust Strains and Changes in Resistance in Coffees

It was realized from the beginning that spraying has its limitations. Mayne and his India coworkers, Dr. K. M. Thomas, Mr. R. L. Narasimhaswamy, Mr. S. Sunderam, and others, began to gather answers to this problem of "break down in resistance" in what had been at one time resistant coffees such as Old Chiks, Coorgs, and Kents. Mayne postulated that it must have been due to differences in races of the rust, and set out to prove it one way or the other, By 1932 he had perfected a method of study; getting pathologic reactions on whole excised leaves and leaf plugs floated on water in glass dishes and kept alive nearly a month on the laboratory table. Through it he established the occurrence of biologic races of

Hemileia vastatrix and the matter of differential host reactions such as are commonly known in many other rusts. These results are represented in the table as follows:

Arabica coffee variety (Differential host)	Hemileia vastatrix race No. I	II	III	IV
Kent family 286	—	+	—	+
S26	—	—	+	+
Sh4	—	—	—	+
Coorg	+	+	+	+

I had an opportunity to see many plants of these differential varieties growing side by side in the field and relative effects were quite convincing.

These four rust races I, II, III, IV, occur in the area of Balehonnur. They are the only ones thus studied, but for the Station they are at the present the most important. They have given significant results and explain the "break down" in resistance of for example K7 that was reisolated from Kents in Kenya and was once quite resistant. Another race of rust apparently arose in Kenya that attacked K7. It has been said that in some cases the improved varieties gradually "lost their original resistance". In other cases it was said this loss became evident in plants grafted onto susceptible roots. The coming of a new biologic race that has been sorted out on the resistant coffee type is the apparent explanation for this turn of affairs. This explains also why Old Chiks, originally resistant, after some years appeared as susceptible, why the resistant Coorgs that came to take their place also were eventually classed as susceptible, why the Kents showed final susceptibility, and why this process can be expected to occur again. This is the same kind of a thing that happens in many rusts. It has been very deeply studied on several crops, the most classic work having been done on cereals.

Rusts are commonly thought of as requiring an alternate host to develop a perfect stage which thus, through gametic (sexual) union gives chance for the recombination of the malleable genes that govern infection; and through this develop other races of different biologic characteristics with respect to virulence. However, no one has ever found an alternate host for the coffee rust. Mayne observed something that takes its place, however. He saw examples of color mutations occurring in lesions on controlled leaf cultures. These were striking and it was evident, that other types of mutations must then occur that deal with variation in pathogenic capacities. Such variation, through mutation in virulence capacities, has been proved to occur in many other fungi, This needs further study on Hemileia vastatrix from many sources.

Some of the Basis for Breeding for Resistance to Rust

Work will have to continue on the mycological phases of coffee rust. The brief summary given above of coffee rust work in India is based on published material. I have spoken mostly of Mayne's work, but he was not the only student engaged. It seems that he did follow some of it that impressed me greatly, in the most detail. The work is still in progress. But Mayne and Narashimaswamy surrounded themselves with their interest. As they worked on their biologic strains of Hemileia they were keeping account of what happened to the plants that showed different reactions to biologic rust strains. As evidence accumulated they began

to see that with certain coffee crosses they secured invariable resistance. On using the progenies of these, certain of them showed a degree of susceptibility when analyzed genetically. This fell into a definite pattern.

Usually when resistance was crossed with susceptibility the first progenies were all resistant. Through genetic techniques they finally came to the exciting conclusion that at least one type of inheritance of resistance to rust in coffee is a dominant character. However, this was not true in all cases. The inheritance complex needs fuller understanding.

In any case, here is the incontrovertible evidence that, even in zones most favorable to its attack, the presence of rust need not be the limiting factor in coffee production. Man now has in his hands the understanding, the techniques, and therefore the power to breed his own brand of the coffee tree that will grow in spite of the rust. He may need to introduce blood from coffee species never used before commercially and heretofore considered purely as curiosities. From such he might get a greatly superior type of resistance. That should be given every trial. Such work has been done with magnificent results in many other crops. Indeed, it is not too far fetched to forsee that the rust on coffee may bring a new age for that crop. As scientists are forced to know more about it, new varieties will be developed that will be better in every way, including quality, than any of those we now grow.

Other Coffee Diseases and Pests

The importance of Hemileia is so great in India, that one finds it difficult to get anyone to say much about any other coffee diseases or pests. Before spraying for rust became an almost universal practice, the black rot, Pellicularia koleroga, was of major importance. The disease follows a fairly regular course of ups and downs. It is most severe as rains of the monsoon seasons lengthen. It is of less effect with the coming of dry weather. There is one student just completing a thesis on this organism to be presented for a Doctor's degree from the University of Madras. (An interesting sidelight is that this University gives only a few degrees over the years. The theses are all given very careful criticism by a board of specialists in European centers. They must pass the Board, and then be given acknowledgment by the University before the examination is due, and before they may be published.)

There are some root troubles in coffee due to fomes. Trees are removed, burned, and the affected region trenched. After a year or two it is replanted and often the replacements live. If not they are again removed, the area followed for another period and replanted again a year or more later. But root troubles are of much less concern than the leaf and foliage diseases.

Coffee is attacked in its dense tops, made so through pruning, by the Pink disease, Pellicularia salmonicolor. Seedlings are damped off by Rhizactonia. Colletotrichum coffeanum causes dieback following rust epidemics. It has been proved that it enters the leaf scars of newly dropped leaves (that came off prematurely?) due to rust. It is a most serious contributing factor to coffee plant deterioration in poorly attended fields. In rust resistant planting, where no spraying is followed, Cercospora coffeicola causes both leaf spots and berry rot. From some very rough observations it seemed to me that certain of the rust resistant coffee varieties were likewise at least a little more tolerant to Cercospora than others. This needs further examination.

The most important insect enemy of coffee appeared to be the coffee stem borer, Xylotrechus quadripes. This attacks the base of a tree and is said to be most serious where the trunks are not well shaded. It is controlled by pulling out badly infested trees. Recently, work on the life history of the insect has resulted in development of an insecticidal application to the trunks at specific times to control this trouble. There is also a small twig borer that causes some annoyance but is, compared to other things, of little importance. In one locality a mealy bug that lives in the fruit clusters of Robusta coffee, has become very serious. This has followed an unusually dry season, when both wet monsoon periods were very light in precipitation. With the return of the rains it is expected that the mealy bug population will be reduced to normal.

Where spraying for Hemileia has been carried on for some years they have difficulty with the so-called green bug (Lecanium viride). The copper-containing sprays seem to have eliminated the natural enemies of Lecanium, for where no spraying is carried on this scale is not easily found. In a few localities planters are having real trouble with "eel worm", or nematodes, that feed on coffee roots causing decay and eventual failure of plants. The Robusta coffee roots are apparently highly tolerant or resistant to eel worm, and this has led to several discussions. I suggested to the growers and the technicians, that they use a two component tree, roots of Robusta and Arabica tops following the approach graft method employed by many, including me, in El Salvador in connection with control of root failure in coffee. These seedlings, I believe, can well be used for replanting diseased nematodes containing soil.

Probably the most spectacular pest of all is the monkeys. India is full of them, and they are protected by tradition. There are cults of monkey worshipers, there are many Monkey God temples, the monkey is an admired subject of many stories and poems, the monkey is considered a friend, it figures in the belief in transmigration of souls, and the roadways are often lived by these interesting but mischievous creatures. In the Punjab and the United Provinces the monkey causes only moderate damage. There, the farming of the dry lands is such that he gets little encouragement to steal from the fields of cotton, kenaf, jute, elusine, gram and such crops. He lives around all kinds of temples; makes occasional forays into scattered fruit trees near villages, but in general, picks up refuse, is a beggar, and carries himself like a scavenger.

However, he thrives in the forest and there regains his dignity. Where there are wooded preserves, he makes them his special place of residence. As you travel to the south of India and enter Mysore State, the hills rise up and gather unto themselves rains. Here the tree growth increases. Here is where the climate is better for coffee plantings, and here it is also better for monkeys. These animals are specially fond of ripe coffee fruits; and they take large quantities in some regions. They also seem to be most attracted to Robusta coffee. Why, no one knows. But they get into the tops of the trees and often split them down the middle. To some planters the monkey neighbors are a real menace. I have been told that there are times when individual growers will lose as much as over 10 percent of their coffee crop to monkey depredations. They can be a very serious pest.

Methods of Growing Coffee

As I have observed the coffee disease and pest situation in India, I have come to the conclusion that at least some of their methods of growing the crop are related

to the troubles farmers encounter. Throughout the years the one greatest enemy to coffee has always been Hemileia rust. It seems that producing coffee as a single -stem sub-tree and cutting off its top so that it will grow low, adds to the ease of spraying operations. In addition, in some cases the extra long laterals are kept in check. Having the trees so pruned that the leaves form a dense canopy about the single thick trunk, appears to be a deterrent to the Large Stem Borer. Also monkeys do not tear the trees apart so easily if they are thus grown.

On the whole all coffee, whether Arabica or Robusta, is grown under shade. There is much unsettled argument among planters about the exact reason for this practice. Mostly it is settled on authoritarian grounds, without actually quoting authority. This is a certainty, that when spray-control measures are faultily applied, the rust diseased leaves hang on longer under shade, and the rust disease may therefore cause a little less damage if the field is under shade. There is also no doubt that dieback is not so severe in coffee that is reasonably shaded than in coffee without shade or in dense shade.

Spacing differs in several localities, but the ideal is one that allows a fairly complete shading of the ground by the coffee trees. On the other hand, trees must be far enough apart that spray hoses can be dragged and spraying carried on between the trees. With the further use of the insecticide BHC and its isomers, on coffee trunks to control borer, a sufficiently wide spacing is going to still be requisite if the best effect comes from these measures.

There is one shade feature that is of considerable interest. Dadap (Erythrina) is grown through most of the coffee gardens. Long stakes of the tree are set at fairly close intervals in the gardens. After these stakes strike root and grow, the foliage is "lopped" at regular intervals and thrown on the ground for organic matter. Such addition, whether from this or other trees, seems to be of much value in coffee growing in India soils. Almost all growers keep the soil clean cultivated, and many dig water retention trenches in their plantations. This latter practice is now being discouraged.

There is a regular, small replanting program in coffee. The rate of supply is about three to four percent per year in old gardens, but it may be somewhat more in the newer areas, due to root disease. Once the plantation enters into a steady year by year growth, and the pockets of root disease get cleared out, it becomes a fairly permanent orchard.

Coffee Seeds Promised and Herbarium Disease Specimens Secured

There is apparently a fairly wide realization that the Office of Foreign Agricultural Relations, U.S. Department of Agriculture, has been carrying on cooperative work in coffee research in the American Tropics for a number of reasonably successful years. We were confronted by this knowledge in all of the coffee countries in Africa, and we found that it was especially known in India. They had been particularly anxious to see more publications and to find out more about it for some time.

When it was learned that Cowgill, who is recognized as a leader in the OFAR studies, was to come to India, all made it clear that we were to get all help possible. The Director of the governmental India Coffee Board Research stations had asked what he should do if we requested seeds of some of the special Indian varieties,

and all joined in saying that we should be given absolutely anything we asked for.

This was a fine reception, and we tried not to ask for everything. At the time of our visit, coffee fruit was still green, and it would be some weeks before it was ripe. However, we prepared a list and gave it to Director Dr. Thomas and the botanist (breeder) Mr. Narasimhaswamy. It included the interesting and unquestionable crosses between Robusta and Arabica, between Arabica and Liberica, and between Arabica and Margogipe (Margogipe fruits on Arabica type plants); the varieties of commercial importance; the coffee strains that give differential host reactions for the four races of Hemileia vastatrix, that is, the Balehonnur strains of: Coorg, S26, S44, and Kent Family 286; a special strain of a late maturing arabica; and as well seeds from the coffee species: Zanguebariensis, bengalensis, and travencorensis. Some other things will also be added according to the judgment of Dr. Thomas and his coworkers.

However, this is not all a one sided program. We made it clear from the very start that we wanted to give as much as possible, in return for receiving. We told them about many things that they had not heard, and they made requests for coffee strains and other seeds, and information and sources of information. It is believed that they will probably receive things of as much interest and value to them as we will get from them. This is our distinct hope and plan.

In addition to seeds obtained or promised, I was able to secure 30 very interesting and select collections of disease material for herbarium study. These consisted of the following: 2 general collections of coffee leaves diseased with Hemileia vastatrix; 9 that dealt with resistance and symptom expression and differential host reactions; 1 each of arabica coffee specimens showing deficiency symptoms, koleroga attack; and root decay from nematodes; Coffea bengalensis having Hemileia spots, the same coffee with another leaf spot, probably Cercospora; Hemileia thomasi on Vangueria spinosa; a rust (Uredo) on Pavetta indica; leaf spots on Hideus that might be a rust (no microscope at hand); 2 of black pepper with Colletotrichum leaf spotting; tea with Colletotrichum attack and tea with Exobasidium blister blight; Coorg orange with "Frenching" (virus or deficiency?); a curious smut on Grewia barberi; Colletotrichum leaf rot of Agave; and 5 disease collections on Kenaf.

Miscellaneous Observations

It has already been mentioned that the workers in India were much interested in what had been accomplished in coffee research in the Americas. Before we were through with our trip into South India, we found that two rather large meetings of planters had been organized which we were expected to address. In both cases it was a combination of European and India growers, altogether four associations, and we were glad to discuss with them some of our problems and learn from them about theirs.

I was asked to speak first in both meetings, and I gave somewhat of a background of why we were there, and our special interests, and brought greetings from our Latin- and U.S.-American colleagues to them. I told the planters about the disease problems on coffee in the Western Hemisphere. These were, actually, of only minor interest to them. They were fully aware that the Hemileia rust that they were saddled with was the most severe of all troubles of coffee anywhere. They also were proud that their technicians had made the greatest contributions

to practical control and that they had the bases for the future in disease resistant lines of coffee. Some reports had been made in India that the "American Leaf Spot", Omphalia (Mycena) flavida, was nearly or as severe in the Western Tropics as the rust was in the Orient. This, however, I could quite readily show was an incorrect estimate. I could also explain on scientific grounds why it would be almost impossible to spread the American Leaf Spot disease to India. On the other hand I was able to get corroboration on the ease with which their rust might gain entrance to the American coffee lands, even with the most careful of quarantine measures.

My remarks were given polite hearing, but the talks by Cowgill were really what attracted the audiences attention. He discussed all phases of very practical as well as more technical problems in coffee growing, and in such a manner that it was evident from the questions that they had not known of much of the work done in the Western Hemisphere. His review of the work of Latin Americans took into account the exceptionally wide range of conditions under which the crop is grown, and the exceptionally wide range in crop productions as well. Some of it sounded almost fabulous to the planters in India. It stirred them to realize that they needed to back further their own research workers in their own localities. Cowgill was insistent that their most important problem was breeding for resistance to Hemileia, and in it the use of blood not heretofore included in their work. He was, moreover, unwittingly, iconoclastic with respect to some of their fondest beliefs, as he had data to show that such staid and fixed practices as they followed in shading, spacings, hole and trench-digging, everlasting clean cultivation, deep soil stirring, laborious types of transplanting, expensive and wasteful fertilization, and drastic pruning practices could and should be reexamined in the light of what their technicians had found and could determine in the future.

These next remarks are of an entirely different nature. As I have observed the variation in reactions of many types and species of coffees to rust infections, I have come to conclusions that I feel deserve recording. These are my own observations, arrived at after only a few months of seeing, and need much study before they could be conclusive. They include what I have seen in herbarium materials from several sources, and observations on living plants in Portugal, seven countries in Africa and in India.

In the first place, Hemileia coffeicola in the French Cameroons and in the Island of Santa Tome is without doubt distinct from H. vastatrix. A leaf diseased with one can be infected by the other as well, and the symptoms remain as clearly distinguishable on the same leaf as on separate leaves. The coffeicola rust tends to greater systemic spread inside the leaf, appearing on the under surface of leaves in a peppered-like covering of minute tufty of spores. These are light yellowish in color in aggregates, and the leaf lesion itself takes on the character of a bruise or a light green translucence. These lesion edges are indistinct in appearance. It seemed pretty well confined to Arabica coffees, but attacks "Laurinas" as well. It flourishes in the colder higher regions where the vastatrix rust is not so vigorous. I did not study it long enough to see if there were any types of coffees exhibiting resistance reactions to it, although Libericas in Santa Tome grow apparently free from attack. Except in herbarium material, it was not seen outside of the Camerouns.

The symptoms of H. vastatrix have been given classic descriptions that need no detailed repeating. The pustules on susceptible Arabica, Robusta, and Liberica coffee strains are round plaques of various sizes, on leaf under surfaces. As they

become thickly covered with spores the round lesions turn to a beautiful orange-yellow color. Tissues of susceptible leaves show no marked discolored line between healthy and diseased parts. Dehiscence of such attacked leaves is quite rapid, although it does not occur before spores have been produced in abundance.

Some coffees, such as certain strains of Liberica and Robusta, show marked development of early necrosis in disease lesions. Around the edges of these, the fungus struggles to produce a few spores. The line of demarcation around the disease lesion is dark inside, with a canary-yellow halo. Coffee strains that exhibit this type of reaction hold their leaves considerably longer than some others.

On examining what appeared to be highly resistant coffees, such as Stenophylla, lesions were found to be rare, but present, lightly covered with spores, and causing no leaf drop. This was true in a few strains of Robusta, and in certain Arabica varieties selected for resistance.

Another type of resistance reaction occurs, for example in certain progenies of Arabica crossed with Liberica. Rust apparently infects the tissues, that then develop into small pimple-like swellings around the point of infection. There is a slight yellowish to tawny discoloration, but in only very rare instances are spores produced on lesion surfaces.

The last type of reaction may be really an artifact. In any case, where nearby susceptible coffees had a full supply of well developed, characteristic rust lesions, some highly resistant lines produced flecking types of marks on the leaves. These were in some cases fairly large spots, and most suggestive of resistance flecking as it occurs in cereal rusts. This fleck on coffee is not to be confused with transluscent lesions I saw due to parasitic lichens or algae. The so-called "weak spot" in coffee in Africa may belong to this rust fleck symptom. However, that has not yet been proved one way or the other. Fungus hyphal have been demonstrated as occurring in "weak spot" lesions. They have been so preoccupied with the Colletotrichum complex that they have rather disregarded rust as a possible cause.

The spread of Hemileia seems to need further study. There are some anamolies that require elucidation. For example, it was first seen on a few trees in Ceylon, early in the year 1869. By the end of that year it was spreading rapidly and had appeared as well in South India, which was a long stride. There seems to be little doubt of such movement. And yet, on the African Continent, the same disease occurs in the French Cameroons, but does not exist in Angola that is r right next door to it. Likewise the Hemileia coffeicola that was described in 1934, resident in the Cameroons and in Santa Tome has not spread, apparently. This is hard to understand, and needs more research. There is grave danger to all coffee if the coffeicola rust should reach beyond where it now exists. It seems a most highly destructive species, and it could completely undo the work of nearly a century in development of coffee resistant to races of H. vastatrix. The mechanism and rate of spread of special vastatrix races has never been adequately studied, although observations indicate puzzling slow encroachment.

It should be noted that we were warmly invited to send materials to India for testing against Hemileia.

List of Institutions Visited

1. Ministry of Commerce and Industry of India, coffee division, New Delhi.
2. Central College of Agriculture, Indian Agricultural Research Institute, Delhi.
3. Indian Coffee Board, Bangalore.
4. Chikmagalur Planters Association, Chikmagalur.
5. Indian Planters Association (of Chikmagalur), Chikmagalur.
6. Coffee Research Station of the Indian Coffee Board (Government), Balehonnur, Mysore.
7. Branch Coffee Research Station, Chitale, Peremboocally.
8. Kenan Devan Hills Produce Co., Coimbatore.
9. Messers T. Stanes Inc. Ltd., Coimbatore.
10. National Agriculture College (and research station), Coimbatore.

This does not include a number of private plantations, owned by both Europeans and Indians

List of Most Important Individuals with Whom We Conferred

1. Dr. K. N. Kaul, Joint Sec'y, Ministry of Commerce and Industry, Central Secretariat, New Delhi.
2. Dr. T. J. Mirchandani, Prin. Hd. Dept. Agronomy, Central College of Agric., Indian Agric. Research Institute, Delhi (CCAIARI).
3. Mr. N. N. Chattey, Librarian, CCAIARI.
4. Mr. N. K. Ray, Estate Mgr., CCAIARI.
5. Dr. R. B. Deshpande, Geneticist on kenaf and fibers, CCAIARI.
6. Dr. R. S. Mathur, Plant Bacteriologist, CCAIARI.
7. Dr. R. Prasada, Rust Mycologist, CCAIARI.
8. Dr. M. K. Hingorani, Gen'l Plant Path. CCAIARI.
9. Dr. S. P. Raychandhuri, Plant Virologist, CCAIARI.
10. Mr. R. L. Munjol, Assistant Mycologist, CCAIARI.
11. Dr. K. M. Thomas, Director, Coffee Research Station, Balehonnur (CRSB).
12. Mr. R. L. Narasimhaswamy, Botanist (breeder), CRSB.
13. Mr. S. Sundaram, Agronomist, CRSB.
14. Dr. N. G. Chokkana, Chemist, CRSB.
15. Mr. K. H. Srinivasan, Director (Ret.) in Mysore.
16. Mr. S. V. Venkataryen, Mycologist, Dept. of Agriculture, Govt. of Mysore, Bangalore, (GMB).
17. Dr. S. V. Govindarajan, Chemist, GMB.
18. Miss R. Shah, Chief Agric. Research Officer, in chg. Agric. Advisory Bureau, Harry Ferguson of India, Ltd., Bangalore.
19. Mr. Appu Menon, Sec'y. Indian Coffee Board, Bangalore.
20. Mr. M. A. K. Pillay, Chief Coffee Marketing, Indian Coffee Board, Bangalore.
21. Mr. S. M. Ramanna, President, Chikmagalur Planters Assoc. and Chm. India Coffee Board, Chik.
22. Mr. K. M. Subbayya, Divisional Forester, Chikmagalur.
23. Mrs. Ganpathi, Rep. small growers, Indian Coffee Bd., Coorg.
24. Mr. K. T. Mathew, plant path. student, Univ. of Madras.
25. Dr. W. W. Mayne, Chief Scientific Officer, Kenan Devan Hills Produce Co., Munnar P.O., Travencore (KDHP).
26. Mr. E. E. Fennell, KDHP.
27. Mr. T. B. Elliott, KDHP.
28. Mr. C. E. Wootton, Mgr. Messers T. Stanes Inc. Ltd., Redfields P.O., Coimbatore.
29. Dr. C. P. Seshadri, Nat'l Agric. College, Coimbatore.
30. Dr. T. Z. Mahamooth, An. Husb., Nat'l. Agric. College, Coimbatore.
31. Dr. B. P. Pal, Director, Indian Agric. Institute, Delhi.

Note: This list does not include names of U.S. personnel who were, as in all the countries where we have worked, of inestimable help.

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

[redacted] REPORT NO. 9

Manila
November 10, 1952

TO: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Department of Agriculture

FROM: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

SUBJECT: Continuation of the World Coffee Trip - Ceylon Report. October 22 - 26, 1952.

There are several romantic and classic stories that deal with the terrible effects of plant diseases on the affairs of men. One tells of the Irish Famine and the resultant migration of men caused by the potato blight. Another tells how cities mushroomed with wealth from bananas in the American tropics, and then were quickly destroyed by a microscopic organism that grows in the soil. Another story tells of deaths and devastation due to a rice disease in India, and another concerns the grim fight of man against rusts of grain. One of the most classic and spectacular of all the tales deals with the rust on coffee in Ceylon. It always starts with how it struck the huge acreages of coffee first in 1869, and the events that quickly followed leading to the complete destruction of that Island's once great coffee industry. Prior to that time there was no country that produced as much coffee as Ceylon, and within a few short years it was an island of bankrupt people, many of whom committed suicide, others who had to be given special privileges through government and private auspices, and others who simply retired from a condition of wealth into permanent poverty.

It was a small wonder, then, that we welcomed the request from the United Nations Food and Agricultural Organization office in Rome, to go into Ceylon, as collaborators and advisors for FAO to make an estimate on what chance there might be to rehabilitate the once famous Ceylon coffee industry. It was a short stop, but fruitful of giving us a never to be forgotten insight into what can happen from the effects of Hemileia rust on coffee.

To show that the Hemileia rust was still a thing of bitter memory in Ceylon, there had appeared in one of the local papers, a reprint of a story from the "Ceylon Times" of October 23, 1877. In it there was a review of the coffee disease situation. Two troubles were specially mentioned, a "white fly" and "Hemileia vastatrix". The little article closed with this paragraph, which I quote in full:

"We believe in Dominica as in Ceylon, careless cultivation and insufficient manuring have invited the presence of disease, and by more skillful and liberal cultivation, it will be got the better of in both countries. We trust that scientific men will soon discover some means of ridding both these scourges."

That was written 75 years ago, when only the very first part of the full measure of that catastrophe was being felt.

The Coffee Hemileia Disease Situation Today

It has been pointed out in innumerable connections that coffee was completely wiped out in Ceylon by Hemileia vastatrix. But you can find the disease, if you can find the coffee trees. The first workers saw many sides to the problem, some of which gave hope. They theorized that changes in or intensification of cultivation or fertilizing would turn the trick. They even philosophized that as in measles with children, when the trees had had a severe attack of spots on their leaves, they would recover and become resistant to further attack. All kinds of treatments were tried, some even going into almost witchcraft and much quackery. But it all came to naught. The disease triumphed. Tea was fortunately on hand and understood as a crop. It took the place of coffee, and then came cinchona and rubber to give living to the island.

At present there are a very few Arabica and Robusta coffee trees scattered here and there in out of the way places. Wherever they are found, one also finds Hemileia. Arabica plants grow exceedingly slowly, because they keep only about two pairs of leaves at the tips of the few scraggly side branches they produce. These trees are weak and hardly more than curiosities.

I found some coffees in the old historically famous Peridenlya Gardens, where the disease was first collected, and from which the organism was named in 1869. There were five kinds of coffee, and on these the disease occurred as follows: 1. Robusta, severe with some leaf fall. 2. Liberica, much spotted foliage but less defoliation than Robusta. 3. Arabica, Kents variety, extremely severe. 4. Arabica, Jackson's "Hybrid", as severely affected as Kents. 5. Stenophylla, showed only a trace of infection, and no leaf drop due to rust.

Coffee is imported to Ceylon for the breakfast table.

What Happened to the Old Coffee Plantations?

As the coffee plantation was repeatedly stripped of its leaves by Hemileia, the growers tried all manner of desperate measures for its control. Spraying failed, because the type of weather (which is very like that found in the American Tropics) required continual respraying programs. The best spray would not stick to the leaves as it should during the long wet seasons.

Even in the best sprayed trees, leaves were rusted, fell, and the trees grew weaker and weaker with each passing year. Poor crops gave way to no crops and then to bankruptcy. Bankruptcy meant abandonment, and then the weeds came in. Occasional dry periods occurred, the weeds and dying coffee bushes caught on fire repeatedly, until even the stumps disappeared. Grasses began to encroach. One can now see the high regions of the Island, the hill tops once covered with fine coffee plantations, with no trees of any sort upon them, and now in tenacious

stands of a poor quality grass. These are the climax, and are the famous "patna" lands of Ceylon, left mostly untilled. Tea is planted below these worthless savannah-like stretches, with rubber plantings in a band below the tea.

We visited some of these old abandoned areas, both the patna regions and the lands that now grow tea and rubber. From what we could determine, it would actually be possible to grow coffee again in those fields. They could be rehabilitated, but only at an extreme price. That would be true even with the use of the finest and best resistant coffee varieties now available, and with the most modern methods of culture and spraying. Economically it could hardly be expected to pay.

Institutions Visited and Technicians Consulted
(not including U. S. Embassy)

The United Nations Food and Agricultural Organization's Mission to Ceylon; technicians as follows:

1. Prof. Evan Hardy, Chief of Mission, Peridemiya
2. Dr. J. P. Bannier, Resident Technical Assistant Representative (liaison officer), Colombo.
3. Dr. H. Hirst, Animal Husbandry, Peridemiya.

The Ceylon Government Department of Agriculture technician as follows:

4. Dr. R. M. Gorrie, special consultant on soil conservation (patna land specialist), Peridemiya.

The Ceylon Agricultural Experiment Station, Department of Agriculture, at Peridemiya; technicians as follows:

5. Dr. W. M. R. C. Paul, Assistant Director, Technical.
6. Mr. L. S. Bertus, Assistant Plant Pathologist
7. Mr. A. V. Richards, Horticulturist.
8. Mr. H. T. A. Sawarsekeran, Librarian.
9. Mr. C. Cailesharan, Assistant Librarian.
10. Dr. M. F. Chandaratna, Botanist
11. Dr. J. W. L. Pieris, Plant Pathologist.

Frederick L. Wellman

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

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REPORT NO. 10

Manila
November 15, 1952

TO: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Department of Agriculture

FROM: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

SUBJECT: Continuation of the World Coffee Trip - Malaya Report, October 27 - 30, 1952.

The country of Malaya is a well moistened, green, elongated peninsula. Seen on the map it hangs down loosely, out of the southeast corner of the Asiatic mainland, and is washed by raingiving waters of the Bay of Bengal, the South China Sea, and the Malay Straits. Singapore is its capital, a modernized Asiatic city on an island at its southernmost tip. The imaginary but most realistically felt line of the Equator, lies close by. The city is a free port, and is one of the most important shipping points in the world.

To the student of world coffee production as effected by the dreaded coffee rust, the peninsula of Malaya holds much historic interest. The story of coffee there, tells something of the spread of the coffee plant and also of the coffee rust that drove it out of there and into and out of many other countries. In the first volume of I. H. Burkill's, A Dictionary of the Economic Products of the Malaya Peninsula, is this interesting information about coffee.

"The date of the first planting (of coffee) outside of Arabica was in 1696, when the Dutch Governor of Malabar managed to obtain, from Mocha, some living plants which were sent to Java. These grew well until 1699, when they were destroyed by flood. In the same year new plants were obtained, and with them cultivation in the East began. Then the tree was sent to Amsterdam, where, in cultivation, it seeded. From one of the seedlings thus raised, which was sent to Louis XIV, King of France, the first cultivation in the West Indies arose, and in 1719 it was established in Surinam. From Goa it was sent to Brazil in 1760."

From this account, that I have long been curious about but have never seen until I went to Malaya, we have something of practical consideration for the Americas. It is something that Cowgill has also been searching for for several years. He

has long been gathering data about the difficulties respecting isolation of variants of outstanding cultural value in the Arabicas in the Western Hemisphere. This was one of the special reasons for wishing to study that species in the Orient, and to bring back new strains into American coffee lands. It is further understandable to a pathologist how little chance there must be, in a vast population arising out of one self fertile individual, to find many disease-resistant strains. The student stands with amazement before the horticultural accomplishments from that one plant sent by King Louis XIV to Surinam. On the other hand it seems possible that the Arabica coffee introduced into Brazil from the country of Goa on the coast of India, may have consisted of several trees, and theoretically the possibilities of greater breadth of genetic constitution in Brazilian coffee are considerably greater.

One cannot help but ponder on how fortunate it was for the Americas that coffee was sent to the New World as early as the 15th and 16th centuries. This was before Hemileia had made its appearance on cultivated plants, from its wild hosts out of Africa. In 1869, much over a hundred years after the first coffee had been sent to the West Indies and Brazil, the disease appeared in Ceylon and in India. It soon destroyed Ceylon coffee, and had stepped over to Java in 1878, and in 1879 was first found in the region of Singapore. This was a bitter experience for the Malay growers, for they had a lucrative trade in coffee and they knew what to expect from what had happened in Ceylon. They had long before established a strict quarantine against seed importations from Ceylon, hoping to avoid arrival of the rust. But such measures did not control its spread by the wind and air currents. The wealth-producing medium lowland plantings of Arabica coffee all became diseased, every hope was soon abandoned, and the desolated growers cast about for other crops to take the place of their coffee trees. Fortunately, for some years the disease did not reach the northern highland regions of the peninsula, but this also became attacked in the end. Arabica coffee is still grown, with difficulty, in the highest parts in small areas.

The coffees mostly grown in Malaya are Robusta and Liberica. One cannot help but realize this when he drinks a bitter cupful for breakfast, and he cannot be censured if he prefers tea instead! There are said to be 10,538 acres of coffee now growing in pure stands in Malaya, and an additional 9,500 acres mixed with rubber and other tree crops; or as Kampong plantings about dooryards with trees of jack, citrus, durian, mango, mangosteen and like fruits. When we arrived in Malaya arrangements had been wonderfully advanced for us with British technicians, through the U. S. Consulate General's office. We were flown out over the bandit-infested jungle and war-abandoned plantations of Johore and intermediate points to see the famous research station and botanic gardens in the security cleared part of Kuala Lumpur, an hour and a half's airplane trip from Singapore.

The Present Hemileia Rust Situation on Coffee

When we got to the Station in Kuala Lumpur, we learned that Arabica coffee plants were almost a curiosity in Malaya because they are so susceptible to rust attack. We went to two of the government field stations, at Serdang and Serdang Bhoru, where coffee varieties had been grown for some years. These had been somewhat badly treated due to war conditions, but I was able to make some observations on rust, Hemileia vastatrix, attack on coffees there. 1. Liberica (Dewevrei) was moderately attacked on all plants. There was some leaf drop due to rust. 2. Arabica had been completely destroyed by the disease. 3. Kalimas, which is a natural cross between Liberica and Arabica, was highly resistant, but leaves

showed small amounts of rust infection. 4. Kawasari, of the same kind of parentage as Kalimas, showed about the same degree of high resistance. 5. Robusta (Canephora) types, of which there were several, all showed only mild or moderate susceptibility except for two individuals that appeared completely rust free. 6. There was one coffee that had lost its label due to war conditions. It had small leaves that were markedly ruffled in appearance, and may have been a Laurina and Arabica cross. This was completely free from rust. On a motor trip taken from Kuala Lumpur and Serdang we saw Liberica grown in a number of Kampong plantings. These were, wherever we examined them, affected with a few mildly rust-spotted leaves.

Other Diseases of Coffee

Although the disease of primary importance on coffee in Malaya is caused by the rust, the crop has other troubles. Of these, the most dangerous is a group of root diseases. They produce the same general symptoms in all cases. Trees sicken and die, and when they are pulled out the roots are found to be badly decayed. Several causal organisms have been identified, the most common of which are a Ganoderma, and Fomes lignosus and F. noxius. Such organisms come from the jungle trees of the regions about. They yield to treatments based on elimination of the diseased coffee trees, and if possible finding the old, original, buried jungle stumps that act as sources of infection. The growers trench around diseased areas, leave open for a year or two the holes from which diseased roots or stumps are removed, and then refill holes and replant with healthy seedlings.

Certain of the common leaf diseases attack coffee. I found spots of Cercospora and also typical examples of branch dieback from Colletotrichums. There are said to be occasional outbreaks of the Pellicularia web blight, and I saw much of the mildly parasitic Cephaleurus that causes leaf spots. Occasionally, Loranths are found in coffee gardens, near to jungle areas or neglected rubber plantations that have become infected with these parasitic flowering plants. On the whole, however, coffee is not being given much attention because of the now much more remunerative interest in rubber, tea, coconuts, and pineapples. And besides, neither Liberica nor Robusta coffee make a uniformally popular drink.

It should be pointed out here, that at one time before the country had given up as an exporter of Arabica coffee, considerable effort and money was expended on spraying to control Hemileia. However, it was found that there were great difficulties. For one thing there is seldom a strong demarcation between the wet and dry seasons. Rainfall averages about a hundred inches a year, and no month passes without some precipitation. Nights are characterized by high relative atmospheric humidity, and there is no time when the soil surface actually dries out. Under those conditions it would be hard to conceive of much of a theoretical seasonal rise and fall in spore production from a rust such as the coffee Hemileia that produces only the one type of infective spore. This was apparently the exact case in Malaya. Probably spore production went on at around its optimum at almost all times. There was always a large quantity of infection material (spores) in the air, and the dews and rains, with intermittent dry periods of short duration, made it ideal for infection and spore development. Spraying was unprofitable under these very difficult conditions.

When sprays were put on they did not last as long as they should. This was because, except for occasional discrepancys, the leaves did not dry to the extent that Bordeaux spray requires for it to stick in the best manner. Spraying had to be repeated at short intervals, both to recover old sprayed leaves, and also

to take care of the numerous successive growth flushes that develop in a climate such as occurs in Malaya. It is known, also that copper spray does have a bad effect on coffee if applied in excess. Spraying in Malaya, if diligently followed, was proved to be a control measure. But it was control bought at such a price, that no one could afford to pay sufficient that growers could make money on Arabica coffee. So they abandoned that fine quality coffee, grew some other crop, or as in a few cases went into the planting of the coarser and poorer species of the more resistant coffee types.

Methods of Growing Coffee

From what we saw, coffee in Malaya is grown as a single-stem, sub-tree. The large Liberica plants are kept somewhat short for ease of picking, and they are spaced rather far apart in the fields. Except where shade occurs by accident in Kampongs, or where coffee is interplanted with rubber or among scattered coconuts, we saw no shade being used over coffee. These Liberica coffee trees are gross in habit, with very large hard leaves, and they can produce crops under crude horticultural handling.

Seeds Secured or Promised, and Disease Herbarium Specimens Collected

(I neglected to give in my Ceylon report information about seeds obtained and specimens collected there.)

While in Ceylon we found some seeds of a Stenophylla coffee. It is believed by us that it may be different from any other Stenophylla now growing in the Western Hemisphere, and different from any that have been secured in other places on this trip, for study in the Americas.

In Malaya supplies of seed were secured from the coffee varieties Kalimas and Kawasari, and Cowgill was promised seeds from the unknown type of tree that we saw that appeared to be a cross, or at least had characteristics of a possible cross, between Laurina and Arabica. In addition several seeds were secured of an unusual legume Psophocarpus tetragonalobus, the "Four Winged Bean," and we were promised seeds from a rare, spectacular flame and orange colored flowering vine, Mucuna benettii.

In Ceylon I was especially gratified to secure herbarium material of six different collections of coffee diseased with Hemileia vastatrix from the old Peridenlya gardens. This is the type locality, from which material was first secured for study and naming in 1869. In Ceylon I also collected herbarium examples of Hevea rubber leaves exhibiting old symptoms of Oidium attack. This is a disease not known on Hevea in the Western Hemisphere.

In Malaya I obtained two collections of Hemileia attack on coffee, and one collection of Marasmius sheath rot of Abaca. The latter is of special interest as this is one of the most serious diseases attacking abaca in Central America.

Institutions Visited

1. Botanical Garden, Singapore.
2. Department of Agriculture, Kuala Lumpur.
3. Federal Experiment Station, Serdang.
4. Branch Experiment Station, Serdang Bharu.

Specialists Consulted

1. Mr. G. H. Addison, Horticulturist, Botanical Gardens, Singapore.
2. Dr. C. J. Voelcker, Director, Department of Agriculture of Malaya, Kuala Lumpur.
3. Mr. A. Johnson, Pathologist, Department of Agriculture, Kuala Lumpur
4. Mr. R. B. Jagoe, Research Officer, Department of Agriculture, Kuala Lumpur
5. Mr. R. Henderson, Agronomist in Charge, Federal Experiment Station, Serdang.

(Note: This list does not include American personnel of our Consulate offices in Malaya).

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

[redacted] REPORT NO. 11

Manila, Philippines
November 15, 1952

TO : Claud L. Horn, Head, Research Development Division, Technical Collaboration Branch

FROM : Frederick L. Wellman, Pathologist, Research Development Division, Technical Collaboration Branch

SUBJECT: Continuation of the World Coffee Trip - Java Report, October 30 to November 6, 1952

There is a long tradition of coffee drinking in the United States Navy. The same is also true of the U. S. Army, but it is probably more ingrained with pride in the Navy. The British seamen have their grog, "the King's ration", and many U.S. Naval traditions are based on old English customs. However, the old puritannical forefathers of the followers of John Paul Jones frowned on alcoholics at sea. It's obvious absence in the wardrooms of the U.S. Navy is a bewildering phenomenon to sailors of other countries. Do the U.S. sailorman compensates with blissfully good beefsteaks, and by consuming superb quantities of what he calls "java". He needs, wants, and has to have at all hours of the day and night, his cup of "java". He can neither wake nor can be sleep without it. And "java" means good coffee, strong and full bodied with a taste one can relish, and a fine quantity of stimulus in a cup.

In the early days there came a time when the one best source of coffee was in bags marked "java", because they came from Java. Along with many purchasing agents, cooks, and mess boys, the sailors, commanders, and admirals, soon took for the good hot drink the rich-sounding word "java". The nickname stuck, it spread everwhere in the United States, and it is still used.

Tradition says that certain old Dutchmen of the fabulous East Indonesian Company brought some coffee plants to Java in 1650, to grow in the colony they had had there since 1610. These early coffee plants must have walked away, for better documented sources tell that a few seedlings of coffee came from the Malabar Coast of India to Java in 1696. These, through mischance, died. The next attempt came three years later when selected plants were successfully reintroduced and established. One seedling from them became the source of all the coffee in all the West Indies and most of South America and all of Central America. The Netherlands Indies plantations also arose from the original Malabar introductions.

To begin with, all the coffee produced in Java was drunk at home. They liked it there, in Java. Occasionally gifts of special consequence, consisting of coffee, went to Europe, and it was well received. However, it was not until 1712 that the first Java coffee was put on the market. This consisted of 894 pounds, and it can be said that world trade in coffee started with that shipment of less than a ton. "Java Coffee" was at one time the standard by which all coffees were measured as they came to market. For over a century and a half it was, justly, the finest and most famous of them all.

This trade would still be flourising in the Netherlands Indies, if it had not been for the coming of the dread coffee leaf disease in the year 1878. One wonders, as he follows from place to place the devastating story of this one disease on coffee, just how much different might have been the history of the Oriental Tropics, and what might have been the result of that impetus that would have come from a long, continuous, healthy and vigorous coffee industry in developing those rich lands along the Equator in the Eastern Hemisphere. Certain it is, that the American Tropics would never have taken over the unchallenged lead that it now holds in coffee production. Especially the production of good Arabica coffee.

The shadow of the chance, constantly present, of coffee rust introduction into Tropical America with the consequent destruction of its coffee industry as occurred in Java, is a sobering and a terrifying possibility.

Before the arrival of the rust that attacked it, the ordinary crop of Java coffee averaged around 70,000,000 kilograms annually. After the Hemileia rust came, within 10 years there were marked reductions, and in another decade the industry was no longer of world importance. In 1927, Java produced 810,000 kilograms of coffee, and that came mostly from the high Idjen plateau in East Java, where difficulties in production are only matched by the fact that the climate is so cool that Hemileia cannot thrive there. Before the last World War there were about 104,000 hectares of coffee gorwing in Java, and about 70 percent of these were in the eastern part of the Island. Since the war there are only about 46,000 hectares, and they are continuously menaced by Hemileia.

The Coffee Leaf Disease Situation

It is said that the Hemileia leaf disease can be found wherever coffee grows in Java. It is certain that it had no difficulty in seeing examples of it in several localities where I looked for it.

Early in the present century, the Dutch scientists began a detailed study of the rust. Hemileia vastatrix, problem. They brought coffees from every source that they could reach. Over a hundred types were obtained, consisting of different species, varieties, and selections. From these they expected to secure, through cross-breeding and selection, some resitant strains or varieties with high quality and good horticultural characteristics. With these they hoped to once again challenge the world coffee market. The work was largely under the leadership of the late Dr. S.J.P. Cramer, at what was then known as the

Buitenzorg agricultural station, now called Bogor. I was able to visit and study his old collections that were still growing, many of which had still decipherable labels. Some of those types killed because of rust were evident, but in most cases the labels where lost from rust-destroyed plots.

In working over the collection it was not possible to always see clear divisions between strains of certain species and strains within different crosses. In consequence little attention could be given to strain differences, and I handled many of them in groups. I tried to make a rough estimate on the severity of rust attack on these plants, and rated the differences. Designations are as follows: O = no disease; T = trace of infection, a few small lesions present, but no defoliation; M = mild attack, usually a fair sprinkling of spots on lower mature leaves on branches but little defoliation, although some leaf drop; S = severe disease, many spots and much defoliation; and VS = very severe attack, very many spots and badly defoliated.

The list of the identifiable coffees that I saw in the Cramer collection follows: (It is to be noted that the disease ratings that occur as a letter after each collection name, are the result of only one observation.) 1. Abeokutae - M; 2. Excelea - T to M; 3. Arnoldiana - M; 4. Robusta - O; 5. A small leaved Robusta - O; 6. Conuga - O; 7. Dybowskii (Dewevrei) - T; 8. Bukobensis - O; 9. Kawasari - T; 10. Kopakota - O; 11. Zanguebariae - O; 12. Perieri - O; 13. Stenophylla - O; 14. Arabica x stenophylla - O; 15. Arabica x Liberica - O; 16. Liberica - M; 17. Klainii (a strain of Liberica) - M; 18. Aruwimiensis (a strain of Dewevrei) - M to S; 19. Conuga, type different from No. 6 - O; 20. Arabica, Kents - VS; 21. Lamborey - O; 22. Congensis, the true wet land or river type - O; 23. Conchai - O; 24. Canephora Kouikouensis - O; 25. Laurentii - O; 26. Robusta x Margogipe - O; 27. Margogipe - killed; 28. Arabica - killed; 29. Quillou - O; 30. Arabica, Celebes selection - M to S and VS; 31. Coffea spontanae - O; 32. Congensis, the dryland type (Canephora) - VS; 33. Kalimas - O; 34. Undesignated hybrid, possibly a Liberica with some small-leaved species, having red tips on all new growth - T; 35. Robusta purpurescens - O; and 36. Canephora "typical"-O.

Of this collection of coffees, Cowgill said he had never species C.perieri (my number 12 above) before. The leaves are rather blunt tipped, thick and smooth, and it grows to be a tall tree as coffees go. We saw trees of several different ages but there were no fruits obtainable. The one I have listed as number 34 was also something quite new to us. Here again, there were no fruits on the plants.

In the breeding program, so Dutch technicians now working with the Indonesian Government told me, it had been found that the nearer the progenies came to true Arabica in plant and fruit characters, the more severely were they attacked by Hemileia. It had been so marked that they believe that the great hope now is to select a strain of coffee that is satisfactory but widely separate from Arabica. It appears that Dr. Cramer was bending every effort in his work towards that end. Through it, he expected eventually to get the perfect coffee, with immunity and all other desirable characters. This is certainly far from present accomplishment, but it may still be the eventual solution to a wide rehabilitation of coffee production throughout the Orient.

A point of considerable interest to me was that it was believed that rust was a major reason for the very marked and distinct biennial trends in productions, characteristic of present Java coffee crops. I was told that sometimes the off years are so low that the crops in some plantations are almost not worth harvesting. When a heavy crop of fruit is grown, it was said to "put the plants into such a condition that their leaves were very much more susceptible to rust."

This, therefore, resulted in greater defoliation after heavy cropping, and possibly absorption of toxins from diseased leaf tissues. The flowering that followed next season was good but the expected thing was a high fruit drop. The light fruit crop that then matured allowed the trees to regain lost vegetative vigor, they were consequently more tolerant of rust attack that season and set a much better crop of fruit. This would be a most intriguing subject of investigation between a pathologist and a physiologist.

Methods of Growing Coffee

The coffee we saw in Java was being grown under shade, and this was said to be done because the rust effects the least damage in shaded plantings. However, I was told that in some areas they grow coffee without shade, or that the shade is very light. We did not see such plantations because there was some danger in reaching these areas and likewise time was short.

Planting distances are dependent on the types of coffee grown. Arabica plantings generally have trees six feet apart in the rows, with eight feet between rows. The Robusta and Excelsa plantations have rows nine feet apart with trees eight feet apart in the rows. Trees are pruned to both multiple and single stems, but in many of the most successful plantations multiple stems are used. This is especially true of the Arabica variety. I was told that with it they try to keep six stems to a plant. After the two oldest have borne 5 to 6 crops they are cut off and two new suckers are encouraged to replace them. This goes on in typical rotation, and was most successful prior to the coming of the rust. In the old days, plantations of Arabica were pulled out and completely replanted at intervals.

The most remarkable horticultural practice found was the common practice of planting coffee clonal material. There are ten popular clones in Java, four of which are the most important. Clones are propagated by nursery grafting at almost ground level, and after they are well started are pinched back to begin multiple stem development. This is one of the developments that have resulted from growing coffee under the disease menace. Growers feel that they require the resistant clones, and that the more intensive horticultural methods give returns.

Present Interest in Coffee Production and in Scientific Agriculture

The current interest in further development and at least partial rehabilitation of the old Java coffee industry is at a fairly high level, but work going on is at present minor in scope. This is due to the fact that the Hemileia rust

problem is so serious, has not been solved, and that there is such a dearth of available technicians. There are few Indonesians with adequately high technical training, and those that are prepared have such a heavy load of responsibilities that they have to use much of their energy remaining after administration on crops like tea, rubber, cocoa, coconuts, rice, and maize that are giving best returns. However, I believe they would welcome work on coffee. They know their island regions, so well studded with volcanoes with rich volcanic ash soils at high elevations, are capable of producing fine coffees. What they need is adequately rust resistant Arabica coffees and new studies on production methods.

There is much hope among the Indonesians for a rehabilitation of the scientific work on coffee and on agriculture in general in the Islands. Young European scientists are being attracted under two to five year contracts, and some old ones are coming back. They are carrying on both the previous lines of research work that have been dropped, and new programs and the training of the natives themselves. Some of the old work that has been interrupted will probably never be continued, and that rich background will then be lost. But a good proportion will be preserved. Also new lines of investigation are in evidence.

In this regard, there is a very hopeful aspect in the warm reception being accorded the United States technicians now working in Java under the Mutual Security Act. After considerable very active work they are being more and more enthusiastically followed. The philosophy of these American technicians of service to the people with whom they work is now all acknowledged and appreciated. The great contribution made by the MSA has been in developing modern aspects of their fisheries. They have worked hard on this, with success recognized in many parts of Asia. It is being used and expanded by the Indonesians themselves. Another proof of the value of help on scientific agriculture is now receiving more and more serious thought and acceptance. This is in connection with the maize-improvement program sponsored under MSA. An important part has been training of native counterpart technicians. This is what they have especially appreciated.

Seeds Secured and Disease Herbarium Specimens Collected

A number of trees were found of the Congensis coffee, river type, from which seeds were secured.

Herbarium specimens were collected and preserved of Hemileia rust attack on Kawasari, Kents Arabica, and Liberica. Specimens of a deficiency symptom on coffee were collected, as were also a leaf spot of tea, young lesions due to oidium on Hevea rubber, two banana diseases, and two maize diseases.

Individuals Conferred With in Respective Institutions

1. Mr. F. W. Parvin, Extension Head, Djakarta; 2. Mr. George Ludwig, Authropologist, Djakarta; 3. Dr. Rober J. Jackson, Corn Breeder, Bogor; 4. Dr. E. L. Waldee, Pathologist and Administrator, Djakarta; 5. Mr. E. T. Habberg, Acting Country Director, Djakarta; 6. Mr. Jorge Madamgo, Rice Specialist, Bogor.

Indonesian Ministry of Agriculture, Institute of Agric., Gen'l. Agric. Research Institute

7. Mr. Amien Tjokrosoeseno, Advisor Estates Agriculture, Djakarta; 8. Mr. R. Sumardjo, Director, Govt. Expt. Sta., Bogor. 9. Dr. J. Vander Vecht, Physiologist (rice), Bogor; 10. Dr. D. V. Doran, Pathologist (corn), Bogor; 11. Dr. G. A. W. Vander Goor, Head Agronomy, Bogor; 12. Dr. A. P. A. Fink, Soils, Bogor; 13. Dr. K. Voss, Fisheries Specialist, Bogor; 14. Dr. J. Schweizer, Special Advisor to Indonesian Govt., Bogor.

Central Experiment Station for Tea, Coffee, and Rubber, Bogor

15. Dr. W. C. Van Hausen, Director; 16. Mr. Hiller Res. Lambers, Plant Breeder; 17. Mr. W. P. Van Knab, Breeder.

/s/ Frederick L. Wellman

Frederick L. Wellman

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
Washington 25, D. C.

(1)

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REPORT NO. 12

Honolulu
November 18 to 21, 1952

To: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Department of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

Subject: Continuation of the World Coffee Trip - Philippine Report, November 6 to 17, 1952.

The first coffee to be grown in the Philippines was due to the efforts of a Franciscan Friar. He brought seeds of the Arabica variety over to the Islands from Mexico in 1744, and it was grown and multiplied as rapidly as possible. Under Spanish rule compulsion was used in the early days, and Governors forced its planting and production in as large quantities as possible. It soon became a good export item, and was of great commercial value starting with the year 1854.

There were a number of regions or several of the islands where coffee was grown but the most intensive area surrounded Lipa. In those early days this was a small village, but it soon became a center of wealth and ostentation, population increased, a fine cathedral arose in the center of the town. Lipa City became an important center in the Philippines solely because of coffee.

For several decades coffee harvests served to add much to the region around Lipa, and there grew up a celebration of the coffee harvest each year. After all coffee was bringing over 4,000,000 pesos annually to the country, and mostly this was to Lipa. The harvest was celebrated with more and more pomp and panoply, The Catholic church was drawn into it, and it also became a time of well earned revelry. Religious processions were organized, and in them the leaves and branches of coffee trees heavily laden with the beautiful red fruits were used in decoration. It is said that floats were drawn through the streets, depicting coffee growing and harvest, and each year some of them were of surprisingly handsome and spectacular nature.

This celebration grew in interest and excitment. However, about the turn of the century a difference became noted in certain of the coffee plantations. Some give the time of this change as the year 1894. In any case, about that time, the

growers began to find leaves on some of their trees marked with brillant orange and gold colored rust spots. Shortly after the leaves became rusted then began to fall. Each year the severity increased, and still, in the face of this menace of the rusted condition of the trees, the harvests were commemorated with the glorious yearly crop festival.

However, once the rust had arrived and become distributed, it did not take long to see that the people could hardly afford the festivals. Where they had been getting millions of pesos before from coffee, by 1913 export had dropped, in pesos, to 817,000. As early as 1889 the pathologists had recognized the true nature of the rust, and could not help but foresee the dire consequences.

It took the destroying disease several years to reach every corner of the Islands. It became known that it was the same malady that had killed off coffee growing in Ceylon, and had snuffed it out in India, Java, Malaya and other nearby countries. As it was more and more felt in the Lipa district of the Philippines, there grew up a feeling that it was some kind of a visitation upon the people, and a superstition that the secular aspects of the coffee festivals were so elaborate that they outshone any religious observances of the celebration. Some said, for example, that coffee branches had taken the place of more sanctified palm leaves, and kindred ideas were put forth. Shortly after that, the festivals became less and less, but the rust increased, and the coffee crop dwindled to very little in the ensuing years. The superstition still holds among certain Philippinoes that they should never again grow coffee, that the crop had become too much worshipped for itself in the long ago, and not growing it is perhaps a form of penance to right wrongs of ancestry.

However, not everyone holds to these unenlightened ideas. The coffee that is produced comes largely from mixed dooryard plantings, the "Kampongs" of the Orient. In these, from what we saw, the trees are very poorly cared for and harvested, using most primitive methods. There are a few regular plantations, but only a handful. Statistics since the war have been somewhat loosely gathered regarding coffee in these Islands. It is estimated that they consume something over 100,000 bags (60 kilo) annually. It is believed that some 20,000 to 22,000 bags are home grown commercial coffee, albeit a great part is of extremely poor quality. Somewhat more than that is actually produced and drunk on the farms, but at the most they produce probably a third of their own coffee requirements. The people of the Philippines like coffee, and coffee probably costs more to the householder in the city and village there than anywhere else in the world. This is due, in the last analysis, to the blasting effects of rust on its production.

Coffee Rust Situation

Here, as in other parts of the Eastern Tropics, rust is by far the most important and the most feared disease of coffee. As has already been indicated, the rust, Hemileia vastatrix, was first positively identified in the Philippines in 1889, although it may have been there a year or two before that date. Some pathologists now consider that a possibility. However that may be, soon after the date noted it had attacked the crop with severe effects and a once important industry was shortly ruined.

There were a number of workers who gave attention to Philippine coffee in those days, and they all realized that the only hope for rehabilitation and continued

production of the crop must come through scientific attention to it. Their primary problem was to combat the rust, and they began casting about for types of coffee showing resistance to the disease. In the years 1914, 1915, and 1916 these technicians brought in from many countries numerous strains of the tree from available sources, and they soon had a fairly large collection. It seems quite likely that this collection might have been considerably larger if it had not been for the first world war that came along at that time. The list of coffees brought to the Islands shows that they were composed of varieties of three main species. There were 29 of Arabica, Coffea arabica, 26 of Robusta, Coffea canephora, 32 Liberica, C. dewevrei, and three strains of a Liberica-Arabica cross called Kawasari.

These coffees were planted at three different locations, with species growing side by side. One series was at a low altitude where the disease was severe, one at a medium altitude where it was also under severe disease conditions, and one series at a higher altitude where there was a little less disease severity than in the other two experimental plantings.

The first finding was that certain known susceptible Arabica varieties were soon killed by the rust as expected. Certain others at first showed high degrees of tolerance. But, in a few years one after another of the highly tolerant Arabicas showed more and more rust, until they were placed in the fully susceptible category. On the whole, Robustas and Libericas were typically different from Arabicas in that they showed only slight, although evident attack from the first. There were some of these that appeared to gain in susceptibility as the age of the experimental plantings increased. This was never quite clearly explained but it was reported that it was probably due to "break down in resistance" caused by prolonged contact with the disease organism.

In the meanwhile the coffee rust became worse, hopes for the coffee future fell, interest lagged, coffee prices dropped, and no large effort was expended on coffee rust research. To be sure there had been work that showed how the disease could be controlled by sprayings with Bordeaux Mixture at fortnightly to monthly intervals; but this added prohibitive costs. When attempts were made to reduce spraying to longer intervals, the only result was that the disease increased and crop losses were greater.

Slowly at first, and then rapidly and more surely, this whole situation deteriorated. Rust and then economics combined to make coffee growing extremely unsatisfactory. It is not to be wondered at that the Philippines lost interest in Arabica coffee. They let their once rich plantations die, or replanted them to coconuts, maize, and many other crops. Many wealthy coffee men became poor, some sold their lands at pitifully low prices, and some left their old homes never to return. A few attempted to grow the Robusta and Liberica or Excelsa coffees. This they found could be done, but much of the home grown coffee is sold by the growers and if they can afford it they purchase imported coffee to drink.

In travelling over the important, Batangas, coffee area, I looked for rust on the numerous Kampong and small plantation growths of coffee encountered. Included in this area was the environs of the old Lipa City region. Wherever I stopped I could always find Hemileia rust spots on the Robusta, Liberica, or Excelsa trees I examined. A single Arabica plant was seen in a dooryard in the middle of the city of Rosario, and this tree was free from disease. The possibility that it might be a resistant Arabica should not be overlooked. Also, a

chance escape is likewise to be considered. Such things deserve study. However, coffee has other pests and diseases in the Philippines, which should also be mentioned.

Other Pests and Diseases

The most serious insect pest of coffee is due to the Red Borer, Zeuzara coffeae. This attacks branches, may be quite serious at times, and is controlled by pruning off infested parts that are then burned. In some seasons a coffee scale insect increases to high proportions. It can become quite a serious pest, and at times tobacco decoctions and similar insecticides are employed to reduce its numbers. In the days before the second world war, occasional troups of monkeys were found to be rather troublesome on coffee. They ate the fruits, broke branches, and could cause serious damage. In some plantations dogs were often kept for the special purpose of frightening these animals away. Since the time of military actions in the country both the Japanese and Allied armies did away with the monkeys, for they were embarrassingly able to give away some of the most carefully executed army movements. These animals are now of minor trouble to coffee owners.

There are a number of diseases on coffee other than rusts. I found typical Cercospora leaf spot that is also said to be serious under certain conditions as a fruit spot. Colletotrichum dieback was found to be common, but nowhere was it seen as specially severe. The locally known "smut" was pointed out to me. It is caused by the black Capnodium fungus that lives on the secretions of sucking insects. This trouble is a rather superficial one, and need not have very serious effects. It is readily controlled by killing the sucking insects that produce the secretions upon which it lives. It is reported that seedling damping-off occurs, caused by Rhizoctonia. Several simple soil treatments have been used to keep it under control. Probably the most unusual disease fungus reported from the Philippines on coffee is Sclerotium rolfsii, causing serious decay of seedlings. This has been severe in localized parts of fields, and it has been controlled by soil treatments and eradication measures.

In many countries it is possible to observe methods of growing coffee that have become commonly accepted that had probably started as a measure to control insects or diseases. I observed nothing of this sort in the Philippines.

Methods of Growing Coffee

It has already been pointed out that the great bulk of what coffee is produced comes from trees in Kampong or dooryard plantings. Small plantations were also seen grown in isolated groups with coconut palms acting as shade, and some larger plantations between rows of coconuts in copra plantings. The coffee plantings we saw were almost invariably mixtures of Robusta, Liberica, and Excelsa trees. There is also said to be a few acreages of Arabica coffee struggling against the rust in high land areas. However, we did not reach these. They were isolated, at some distances, and they were in militarily unsafe parts.

The Robusta, Liberica, and Excelsa trees we saw were allowed to grow tall and without much apparent attention to cultural practices. Seedlings that spring up are moved to convenient locations around dooryards and within fenced enclosures, or if they were taken to more extensive plantations they were only roughly spaced. In many places we saw, it was difficult to determine if the trees

were in rows. These tree types were allowed to grow large, so that in some cases harvesting is done by a combination of climbing the trees and beating off the fruits with bamboo poles.

It was plain to see that the people of the Philippines were in a rather discouraged state about growing coffee. However, I talked with one grower, a coffee buyer, and numerous technicians and agricultural specialists about this particular state of affairs. All said that this was not due to lack of interest. All agreed that coffee had become an agricultural product requiring more and more technological attention. They felt that all that they needed was a renewal of the research programs that had been interrupted because of wars in the last decades, to bring coffee growing back in full force.

Possible Future of Coffee Rust Studies

The persons interested in coffee growing realize that the Islands are well supplied with lands very suitable for producing Arabica coffee, to fully take care of their own needs; if it could only be grown rust free. In spite of superstitions against it, there are several growers who are ready to plant new lands. Some are being planted. The most hopeful factor is the presence of a number of well trained Philippino scientists. These are excellent students, have fine reputations in the world of Agricultural Science, and have a long tradition of productive work.

These men realize what a program to develop the proper kind of rust resistant coffee would entail. They know that biologic races of the rust have been found, and that this accounts for the "break down" they once observed in resistance in some of the coffee strains they had introduced to replace old susceptible strains. They fully appreciate how exhaustive must be the genetic work necessary, both with respect to the rust organism, and to the coffee plant. Lastly, they have a realization that such work on coffee to result in control of the rust, will also develop in the end a better understanding of the whole coffee genus than could ever be known otherwise.

They are a confident group of scientists. They know that with assistance, that would have to be given wherever the work was done, that a coffee breeding program to control a disease will do more for coffee growing and production than anything else in the world.

It is well to point out here that Cornell University is working in a close cooperative and official relation with the University of the Philippine's College of Agriculture in Los Baños. Cornell is carefully and wisely using its best thinking in the rehabilitation of war-interrupted scientific endeavor at Los Baños. At this college of agriculture, with its long history of accomplishment in the Southeast Asia Region, there seems to be evident a not unreasonable expectation that it may become the foremost scientific agricultural research and training institution in the Orient. The Cornell professors were as much interested in our findings about the coffee rust as were the Philippine professors, or the men of the Mutual Security Agency, or the American Ambassador and those working on agricultural problems under him. We were most warmly invited to work at Los Baños by the Dean of the college, by the head of the Department of Agronomy, and by the head of the Department of Plant Pathology.

List of Scientific Institutions Visited

1. Offices of Bureau of Plant Industry, National Department of Agriculture
2. Offices and laboratories of Pest and Disease Control services, B. P. I., National Department of Agriculture
3. Bureau of Extension, Department of Agriculture
4. Executive offices of the College of Agriculture of the Philippines (part of the National University), Los Baños
5. Offices and Laboratories of research and teaching divisions (Pathology, Entomology, Horticulture), College of Agriculture, Los Baños
6. Mutual Security Agency (technical cooperation in agriculture) of the United States

Individuals with whom we had important conferences
(This does not include U. S. Personnel, farmers, or commercial men)

1. Dr. T. G. Fajardo, Plant Pathologist, Bureau of Plnt Industry, Department of Agriculture, Manila.
2. Mr. F. Otanes, Chief of Pest and Disease Control, Department of Agriculture, Manila.
3. Dr. N. G. Teodoro, Sr. Pathologist, Bureau of Agriculture Extension, Department of Agriculture, Manila
4. Dr. G. M. Reyes, Pathologist, Bureau of Plant Industry, Department of Agriculture, Manila.
5. Dr. Gonzalo Merino, Director, Bureau of Plant Industry, Department of Agriculture, Manila.
6. Prof. E. Roldan, Pathologist (forestry), College of Agriculture, Los Baños.
7. Dr. F. G. Galang, Assistant Director, Bureau of Extension, B. P. I., Department of Agriculture, Manila.
8. Dr. Carlos Burgos, Poultry and Animal Husbandry, Bureau of Extension, Manila.
9. Mr. D. B. Pagiurigan, Assistant Pathologist (rice), Bureau of Extension, Manila.
10. Dean L. B. Uichanco, Director, College of Agriculture, Los Baños.
11. Dr. and Prof. G. C. Ocfemia, Head, Department of Plant Pathology, College of Agriculture, Los Baños.
12. Dr. P. A. David, Head of Agronomy (coffee), College of Agriculture, Los Baños.
13. Dr. F. T. Orillo, Assistant Plant Pathologist, College of Agriculture, Los Baños.

Frederick L. Wellman

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF FOREIGN AGRICULTURAL RELATIONS
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[redacted]

REPORT NO. 13

Washington, D. C.
December 16, 1952

To: Claud L. Horn, Head, Research Development Division, OFAR, U. S. Department of Agriculture

From: Frederick L. Wellman, Pathologist, Research Development Division, OFAR

Subject: Continuation and Conclusions of the World Coffee Trip - Hawaii Report, November 19 to 23, 1952.

Every place that we have gone on this study has been very different from any other. There has been not a single moment of boredom and nowhere have we encountered anything but a feeling of helpfulness and friendship. This has been specially true of our experiences with the scientific staffs.

Our attitude from the start was that we were to sit at the feet of our hosts, if they would allow us, absorbing what they would vouchsafe to us of their much older works. We wanted also to get the feel of the traditions respecting coffee growing and its problems. We were also anxious to learn about studies and observations that had never gotten into the more readily available publications. It is a commentary on the world-wide attitude of scientists that in no place were we disappointed. They even turned the tables, extracting from us anything we knew from our own experiences. We did all we could, gladly, in many cases arranging contacts between individuals and institutions, thus assisting in a manner we thought of value to all.

We followed this as well in Hawaii, that most unusual outpost of all the unusual parts of the United States of America. These Islands are gems of the Central Pacific Ocean. They are not only the wonderfully beautiful, richly and fruitfully, green clothed, red and black colored islands, bathed by unbelievably cerulean blue waters, they are also lands of romance and, some believe, the perfect counterpart of what man calls paradise.

It is now known that the Islands have been populated, probably for upward of two millenia. However, the modern discoverer was the adventurous Captain James Cook, who saw them first on one of his voyages under the auspices of the Fourth Earl of Sandwich in 1778. For years the islands were known as the Sandwich Islands, named by Cook for his benefactor. They were used as a welcome place

in mid-Pacific for scurvy ridden crews of old sailing vessels to regain their health, and for way stations, to secure new supplies of food and fresh water. They attracted to their shores men and women of many religions, people who were Asiatics and Westerners, Russians, Polynesians and Africans. Many of the best of them remained, and the archipelago is now richly endowed with a wonderfully interesting, busy, mixed population. It is a proud conglomeration, proving that without respect to origin, race, color or creed, that the man is what counts. The Hawaiians themselves applied for annexation to the U. S. A. at first, unsuccessfully, in 1893. The request was repeated, and in 1898 it was accepted and the nine islands have been a part of the country ever since.

Something About the History of Coffee in Hawaii

It is of interest to note the dates just mentioned, comparing them with some of the steps in the history of Hawaiian coffee. The first recorded planting of coffee was in 1813, although it must have been brought in before that; probably from the island of Tahiti, and possibly through French influence. It is said that in 1825 no lesser a person than the great English liberal and poet, Lord Byron, brought living coffee plants to Hawaii from Brazil on the ship Blonde. This Arabica strain has been kept fairly pure, and is apparently the one known as the "Hawaiian Strain" to this day. The tree is vigorous, with strong lateral branches and is of the so-called Bourbon type. The progeny seeds of these original Lord Byron introductions were taken to the famous Kona region on the island of Hawaii in 1829 and the strain has remained there since.

The first shipment of Kona coffee was made in 1845. It consisted of 248 pounds of cleaned coffee. The quality of this coffee received immediate high acclaim. It was in the process of building an enviable position as a source of overseas business when the California gold rush of 1849 came. With it the men of the Islands shipped to the west coast of North America in flocks, and left the Kona district in Hawaii to abandonment and disrepair. During this time Kona coffee was kept producing in only very small plots for local consumption. Between the years 1860 and 1890 coffee growing in Kona was almost a forgotten farm art. Shortly after that interest in the crop again revived. About the year 1893, someone brought over to Kona a few seeds of Arabica coffee from Guatemala. The trees from those seeds were a more delicate type than the so-called Hawaii Strain of coffee, with drooping lateral branches. But these trees produced coffee of excellent quality. This strain was planted widely as "Guatemala" and is still extant in Kona.

The coffee in those early years was mostly produced in small quantities, and it was drunk largely in the Islands. Some farmers began to make a small amount of extra money from their efforts. Interest in coffee then began to revive once more. About that time the Islanders had, through repeated insistence, become attached to the United States. Visitors and Government representatives from the "Mainland" drank the coffee and became acquainted with its distinctive flavor and high quality. Not only was the coffee good, but it had a romantic appeal, and it has held that to this day. The demand grew, and coffee farmers began to make conservative additions to their plantations.

Two decades after this, world wars began making themselves felt in the coffee industry of Kona. The American Army and Navy had its representatives who came to Hawaii for military reasons. Officers and men who drank it, valued the high quality, distinctive flavor, and strong stimulus of its cup. Some of them made

special shipments of it; meanwhile the coffee drinking population of the United States had increased and by 1930 the Kona district was producing some 10,000,000 pounds of clean coffee annually. Along about that time difficulties once more arose. There was trouble with shipping, Brazil was flooding the world market with its comparatively cheap coffees, there were other more indirect economic effects, and the result was another regression in production of Kona coffee.

However, after a time, coffee prices once more increased. Before long the incident of the attack on Pearl Harbor had occurred, and prior to 1950 the coffee plantations in Kona were again being rehabilitated. In that year there were 680 farmers once more growing the crop on 3,403 acres, and they produced that year a little over 7,000,000 pounds of coffee. Since that time there has been considerable increase in the planted acreage and production, and this is still advancing. Kona coffee is grown entirely on small farms, by farmers who were originally of Japanese stock but of course are now U. S. citizens. They are excellent horticulturists, taking advantage of every modern discovery dealing with their business. Kona is on the largest one of the group of nine islands, named Hawaii, from which the rest of the group has taken its name.

The Kona District

The Kona District, its inhabitants like to capitalize both of these words, is a narrow strip lying along each side of a high road that follows around the westerly reaches, far below the snow fields, of the extinct volcano, Mauna Lao. The elevation of the District ranges from about 1500 to 2000 feet above sea level. The blue Pacific can be sighted from practically any part of the District, providing it is morning. There is usually a pleasant ocean breeze coming in at this time, that dies down to almost complete stillness shortly after noon. Clouds accumulate rapidly, and every day, by two o'clock in the afternoon, there is no sun shinging in the District. This is the famous automatic shade of which the District boasts.

Rains usually start at about this hour, if it is the season, with gentle determination. Precipitation averages from about 60 to 85 inches a year. The temperatures are remarkably equable, and range from 60 to 80 degrees Fahrenheit. The night air is said to be very moist, and usually the trees are heavy with dew in the mornings. Severe storms are never experienced, so I was told, and the whole feeling of the atmosphere is that of a benignity and pleasantness that cannot very well but attack the people who live in it, with great affection, to their homes and coffee trees.

Kona District soil, it might be said, is no soil at all; it is a medium in which trees may be propped up to grow. It consists of broken and more or less ground up blocks of lava from prehistoric eruption of the volcano Mauna Lao. There are several lava flows that make up the formation about Kona, but the coffee farmers prefer those that consist of the darker rocks with shades of blue in the more recently broken surfaces. Originally the lava was covered with a scrubby growth of short island trees of several species, and some bushes and low herbs. These were cleared and holes for coffee trees were made by use of crowbars and picks. The only soil worthy of the name was decayed and partly rotted vegetation over the rocks. This was gathered up and packed about the roots of the coffee trees transplanted into the rough holes described. The lava deposits are broken, as already mentioned, deep, and irregular, resembling talus or road fill. As an example of the chemical contents of Mauna Lao lava, I found in a 1917 publication

the following: Silica 52.07 percent, Alumina 14.12, Ferric Oxide 2.64, Ferrous oxide 7.01, Manganese oxide 0.72, Calcium oxide 10.71, Magnesia 7.51, Potash 0.74, Soda 1.93, Sulphur trioxide 0.35, Phosphorus pentoxide 0.24, Titanic oxide 2.42, and moisture 0.00. The lava fields extend many thousands of feet up the sides of the mountain, clear down to the Ocean. But they are only cultivated in a very narrow strip. The coffee plantations give an impression of vigor and health in the District, as well as do most of the other plants growing in the region.

Coffee Disease and Pest Situation

In going through the District I stopped and visited a large number of plantations. I saw several thousands of trees and gave them close attention. Looking with as great a care as I was able, I found no real disease. I was specially anxious about Hemileia rust. I kept constant watch for any leaf blemish even suspiciously similar to this disease but found nothing. For years this has, likewise, been under perpetual observation by trained workers in the District, but no one has ever found it thus far. No leaves showed spots of any sort, and even where trees had borne heavy crops and there was evident dieback from excessive production, I did not see what I could diagnose as clear cut symptoms of dieback from infection by the Colletotrichum fungus.

In a few year old trees I found some scale insects, with sooty mold (Capnodium) following deposition of excretions from those insects. The sooty mold was said to be readily controlled by the new insecticides that kill the scales. Otherwise I saw no evidence of any fungus, even of slightly parasitic lichens or algae.

I saw, in one place, where trees had been considerably injured by common rats. These animals had climbed heavily fruited trees, and broken back the lateral branches. At one time this had become a serious problem. The rats were numerous and attacked a large acreage. Recently, however, they were being controlled by the use of the new organic rat poison, Warfarin.

I could see no reason why those coffee plantations should have not had any of the common leaf troubles, except that they had apparently never been introduced. To see an entire coffee district with no diseases was an impressive sight, unique, and to a pathologist, most remarkable. I told the growers of Kona, I hope it was understood as humorously, that I was most disappointed not to see diseases! With no diseases there would be no good reason for my going back to work the rest of my life in those beautiful islands.

I attempted to find if there was some special characteristic of the growing methods in the Kona District that might explain the unique freedom from diseases. The more I thought about it, the more it seemed that conditions of growth were unique as the freedom from diseases.

Methods of Growing Coffee

To anyone who has had experience with coffee growing, it can be seen that Kona coffee is not being produced under any conditions that would eliminate disease. In fact the contrary is true. Planting is close, and with few exceptions a minimum of pruning is practiced. All environmental conditions are good for any number of the more than 40 diseases that attack coffee. I have already mentioned

that clouds are drawn across the sun, "at," according to tradition, "just the right time." This is also a good condition for many diseases. There is high relative humidity of the air, and at the same time there is sufficient sunshine that conditions are never depressing. In fact, from what I saw, rust should flourish under those atmospheric conditions.

Through the research workers of the Islands a fully practical and universally applied, modern method of weed control has been developed through herbicidal sprays. With these they eliminate both broad leaved weeds and as well grasses. Water solutions are often used, and oil emulsions are also commonly employed, with pentachlorophenol and other chemicals added. The thin layer of debris and soil on the lava rocks, is the life of the coffee. It is kept intact and as little disturbed as possible. This universal use of chemical weed control was giving excellent results. It had been somewhat forced on the growers by unreasonably high labor costs, but it was enthusiastically accepted because of the simplicity of the method. It was found to be not only simple but cheap, the farmers had much pride in it, and they found the ease of weeding to be important especially because it left undisturbed the surface soil that was so much needed for their coffee trees.

As we visited one plantation after another it became evident that there was considerable difference in vigor in some places. Sections of plantations were visited that showed much yellowing of leaves, and weakened trees. There were areas in which the trees were almost bare of leaves, and the aspect suggested starvation due to lack of fertility. This was found to be the common effect if fertilizers were not applied regularly. However, such trees could be brought back to full vigor in two year's time after fertilizing was renewed. It appeared that in the Kona District, coffee could not be produced without fertilizers used in large quantities, at regular intervals. The fertilizer formulas most commonly used are 10-5-20 and 8-5-17. Amounts used are from 1000 to 1800 or 2000 pounds per acre per year.

Fertilizers have been used since 1910, and these are spread around the bases of the trees without disturbing the soil surfaces. Some growers apply the first fertilizers of the year before the main flowering of the trees. Another group of growers put their first fertilizers on just after that. The exact time of flowering depends on weather, but it comes during the first three months of the year. A common time to apply fertilizer is March or February. This comes after all the crop is harvested, all dead branches have been removed from trees, and any necessary pruning is completed. Another application may be put on in May or June, and another just before harvest starts. This third application is a light one and usually comes the latter part of July. If a fourth application is put on it comes "during the winter," and may be from September to November.

Conclusion

Hawaii was to us a sort of climax to this world girdling trip. It was full of wonder and interest, although we were so full of experiences and new information that we felt like sponges heavy with strong wine, utterly unable to hold another drop. After all, this was a visit to coffee growers and scientists on our own United States soil. Also there were things we had read about in the Kona coffee district in Hawaii that we felt we needed to see to round out our knowledge about the crop.

As in all of our stops, the time was too short. But we had a schedule to follow, and we knew we had to carry it through in a few days. For the purpose originally planned, we believe we accomplished there, what we needed.

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I expect to prepare, soon, the last one of the reports covering this trip. It is to be a resume of the whole effort. We traveled over 36,000 miles on the whole trip, in Europe, Africa, Asia, and the Islands of the Southeast Asia region. We crossed the Equator fourteen times, touched a total of 25 countries and worked in 18 countries. On this trip we took 36 different airplane flights, visited 95 different scientific institutions and had conferences of value with 218 scientists. We met a great many growers and other scientists. We found coffee seeds of interesting and valuable species and types in almost every country where we worked. Everywhere we secured materials with ease, and as a consequence will have upwards of 150 new coffees for work in the Western Hemisphere. There will be some duplications, but the chances for strain differences are limitless even in duplicate collections. I secured 143 dry and preserved herbarium specimens of diseased coffee materials on this trip. I consider all of them notable, but this is probably a prejudiced point of view. A large number of colored pictures were secured and I took a total of 456 photographs of interest for black and white reproduction, all with titles and annotations.

Combining this trip with our Latin American experiences we have now seen and worked in every important coffee growing country of the world. We should now have a list of all the known coffee technicians that are alive, and know the problems being faced by them.

While we were specifically studying coffee on this trip, we could hardly be expected to close our eyes to other matters of interest in Scientific Tropical Agriculture. Some of the knowledge we secured along the way forms a rich side line of information.

Both Cowgill and I consider ourselves fortunate in having made this trip. It is to be hoped that the very greatest value can come of it, not only to ourselves but to everyone else all around the Tropical World.

Institutions Visited

1. Hawaiian Federal Agricultural Experiment Station
2. University of Hawaii
3. Kona Coffee Experiment Station
4. Pineapple Research Institute of Hawaii

Scientists Conferred With

1. Mr. L. Baron Goto, Assistant Director, Hawaiian Federal Agricultural Experiment Station
2. Dr. W. B. Storey, Pomologist (H.F.A.E.S.)
3. Miss Euphie Shields, Librarian, University of Hawaii
4. Dr. J. H. Beaumont, Horticulturist (H.F.A.E.S.)
5. Mr. John Iwane, County Agent, Kealukekuo

Scientists Conferred With

6. Mr. Clifton J. Davis, Entomology and Plant Quarantine Inspector, Board of Agriculture and Forestry, Hilo
7. Mr. William C. Look, Chief Plant Inspector, Board of Agriculture and Forestry, Honolulu
8. Mr. Takashi Harai, President, Kona Coffee Leaders Association, Kealakekua
9. Mr. Edward Fukunaga, In Charge Kona Coffee Experiment Station, Kona
10. Dr. Robert L. Cushing, Director, Pineapple Research Institute, Honolulu
11. Dr. Walter Carter, Entomologist (P.R.I.)
12. Dr. E. J. Anderson, Pathologist (P.R.I.)